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THE OLDMAN RIVER DAM MULE DEER

Adult Female Ecology in a
Changing Landscape

Job Completion Report

Prepared for

Alberta Environmental Protection
Natural Resources Service, Prairie Region,
Water Management

Prepared by

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Abstract

The effect of construction and operation of the Oldman River Dam on the local mule deer (*Odocoileus hemionus*) population at the three rivers site in southwestern Alberta was met with speculation. In response, the government of Alberta initiated field studies during the construction phase of the project to investigate the response of resident mule deer. Data collected beginning winter 1989-90 and continuing through 1996 included:

- complete-count winter aerial surveys conducted by helicopter;
- trapping, radio-collaring and subsequent relocation of 31 mule deer;
- physical measurements and blood tests from trapped deer; and,
- intensive monitoring of female deer movements during parturition.

Population estimates were derived from expanding the total count of deer from winter aerial surveys based on the sightability of individuals with radio-collars. Sightability of mule deer varied from 0.625 to 0.739 between two consecutive winter surveys. Between 1989-90 and 1993-94, the mule deer population apparently increased with an average annual rate of 11%. The observed population increase is consistent with relatively high average annual reproductive rate of 1.33 fawns/female, combined with a low annual adult female mortality of about 18%. A simple population model was constructed to simulate the combined effect of observed population parameters on population growth. The model also served as a "test" for assumptions about other population parameters.

Mule deer trapped at the Oldman River Dam for radio-collaring were in good to excellent body condition; the prevalence of winter tick was low. Hybridization with white-tailed deer (*Odocoileus virginianus*) was identified in three female mule deer from 66 blood samples. Female mule deer at the Oldman River Dam were non-migratory, and maintained relatively small, stable home ranges. Multi-annual home ranges average 14.71 km^2; multi-annual winter ranges averaged 8.18 km^2. Parturient females returned annually to the same general area within the home range to give birth, however, fidelity to reproductive areas was "patch" specific only on occasion. Reproductive habitat was closely associated with the river valley, important habitats included riverine cottonwood, coulee shrublands and grasslands in benchlands.

The mule deer population that inhabited the three rivers valley of the Oldman Reservoir has remained large and viable since dam development and operation. Prospects for the Oldman mule deer population appear to be favorable.

Acknowledgments

This report was compiled by Garry E. Hornbeck, M.Sc., P. Biol., of Wildlife & Company Ltd., Calgary (formerly of AXYS Environmental Consulting Ltd., Calgary). Intellectual support, critical comment and review at various stages of preparation was provided by Dr. John Mahoney, P.Biol., Project Biologist, Oldman River Dam, Natural Resources Service, Alberta Environmental Protection. Review comments of the draft manuscript were also provided by Rick Lauzon, B.Sc., P. Biol., and Kevin Lloyd, M.Sc. of Axys Environmental Consulting Ltd. Review comments on parts of the draft manuscript were also received from Dr. B.L. Horejsi.

A large number of people contributed to this report. The deer study was conducted initially under the auspices of Al Nilson, P.Eng., Manager of the Oldman River Dam Wildlife Mitigation Project, and subsequently under the direction of Dr. J. Mahoney. Garry E. Hornbeck had a lead role in the deer studies and has been responsible (with other biologists from Axys) for producing a number of annual progress reports provided to the Oldman River Dam office. Other wildlife biologists at Axys; namely Peter Balagus, B.Sc., and Richard Lauzon assisted with trapping and radio-collaring and some aspects of data collection. Rick Rowell, B.Sc., of Axys assisted with development of the population model.

The mule deer project benefited from volunteer efforts by students from Lethbridge Community College. Their involvement occurred during the first year of trapping and radio-collaring, arranged by Galen Armstrong of the College. Various employees from Alberta Environmental Protection, Natural Resources Service, participated during winter aerial surveys. Gordon Hoffman (local area rancher) was retained under contract for radio tracking during 1992. In later years, employees from the Oldman River Dam office also assisted during trapping and subsequent radio tracking with direction from J. Mahoney. Acknowledgment for all of the dedicated people who have contributed to these deer studies have been provided in the series of progress reports that have been prepared.

Bob McClymont and Tom Packer, Forensic Scientists, Alberta Environmental Protection, Natural Resources Service, Edmonton, tested blood samples for possible hybridization with white-tailed deer. Keith Ferguson, Alberta Environmental Protection, Natural Resources Service, Operational Support Branch prepared the GIS map products.

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1.0 INTRODUCTION

This Job Completion Report presents a compilation and analysis of various pieces of ecological information obtained on mule deer (*Odocoileus hemionus*) at the Oldman River Dam in southwestern Alberta. Various field studies were funded by Alberta Environmental Protection, and were conducted between 1990 and 1996 (Appendix Table 1 - List of mule deer progress reports). Most of the information was obtained from post-construction fieldwork; substantially after the Oldman Reservoir was filled to full supply level (June 1992). The overall objectives of the Job Completion Report were to synthesize the available information for the purpose of identifying the local population's characteristics, and what may be revealed about the mule deer's response to dam construction and reservoir operation.

Winter aerial census of mule deer were initiated in winter 1989-90 and repeated during winters 1990-91, 1992-93 and 1993-94. Mule deer were captured and radio-collared during winter 1991-92. Additional captures were repeated with lower levels of trapping effort during winter 1992-93, 1993-94 and 1995-96.

Study objectives pursued at different stages of mule deer investigations included:

- population enumeration, and estimation of population change;
- seasonal movement patterns and annual home range use; and
- behavior of parturient females and the identification of reproductive habitat and individual female productivity.

Knowledge of the local mule deer population's size and distribution, its local and seasonal movements, productivity and mortality aids the assessment of potential impacts of dam construction. This knowledge also assists continued management of the available habitat within the mitigation land base that is being managed by the province of Alberta for wildlife mitigation projects.

1.1 Background

Mule deer are the most visible and economically important wildlife in the Oldman Reservoir basin. Concern for mule deer in the three river valleys of the planned reservoir began in 1985 with the preparation of a Phase I Wildlife Overview for the Environmental Mitigation/ Opportunities Plan (Westworth and Brusnyk 1985). The authors of this document identified mule deer as the most important wildlife species in the project area exposed to impacts of reservoir construction and operation. However, for most of the

project area, data on the abundance and distribution of mule deer was noted to be generally lacking.

The Phase I Overview was followed-up with aerial surveys, ground reconnaissance and foot surveys for mule deer (Allison and Russell 1986 and Young *et al.* 1986). Knowledge of the deer population at the time suggested the following:

- river valleys of the planned reservoir were important wintering habitat; numbers of mule deer using the river valley were thought to be higher in winter than during other seasons;
- numbers of mule deer in the river valley of the planned reservoir during winter were thought to be about 350 to 400, while in summer the local population was estimated to be about 220 including fawns;
- production and survival of mule deer were thought to be high (fawns were thought to be born in early June) with a late winter ratio of 69 fawns per 100 adults;
- no alternative fawning habitat was available above the reservoir's full supply level, except in the tributary creeks and other (upper) parts of the river valley; and,
- relatively large numbers of mule deer would be displaced from their habitat..., and displaced deer will be lost to the population because all suitable habitat in the vicinity of the reservoir is currently occupied.

At the time of the early wildlife studies, the river valleys of the planned reservoir were also occupied by farmsteads and were being grazed by cattle.

An important milestone during the planning process for construction of the Oldman River Dam was the Federal Environmental Assessment and Review Process. A six-member panel was appointed and given the mandate to evaluate and make recommendations on the significance of potential environmental and socio-economic effects of the proposed dam. The review process was conducted between November 1990 and April 1992. A review of available information pertaining to wildlife and potential impacts from the dam by the panel's expert concluded that the database was grossly deficient (Horejsi 1991). The review panel's conclusion was that "several prominent species of wildlife are known to be adversely affected by the project..." (Ross 1992).

Partly in response to noted deficiencies, a monitoring program at the Oldman Dam was developed (Green 1991) and field studies of mule deer at the Oldman Reservoir were intensified. Results of these studies form the basis of the current Job Completion Report.

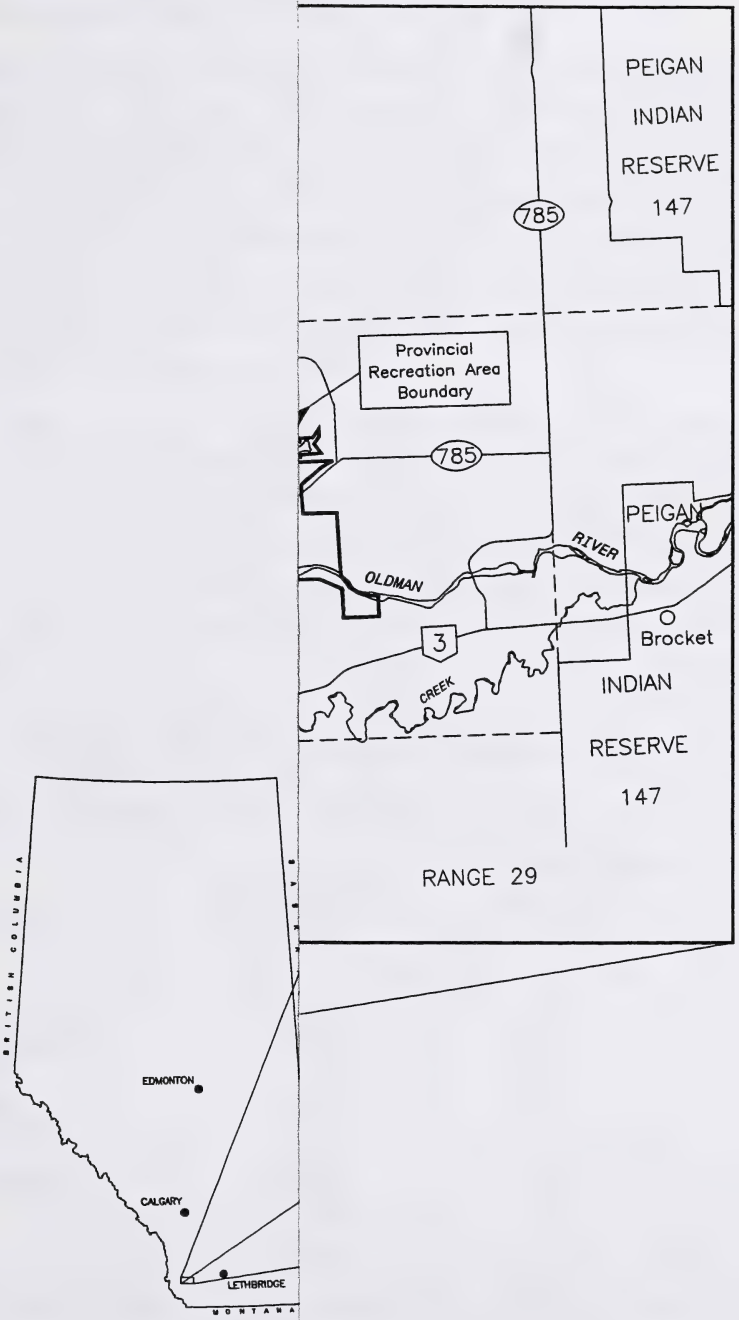
2.0 STUDY AREA

The Oldman River Dam is located in the fescue grassland ecoregion of southwestern Alberta (Strong and Leggat 1992), adjacent to the eastern edge of the Rocky Mountain foothills (Figure 2.0). Three rivers flow into the Oldman Reservoir: the Oldman River, the Crowsnest River and the Castle River. The North Fork of the Oldman River drains the lower slopes of the Porcupine Hills to the north. The Castle River drains the Carbondale Hills along the eastern slopes of the Rocky Mountains. The Crowsnest River drains the southern slopes of the Livingstone Range west of the Reservoir. At full supply level, the Oldman Reservoir occupies about 15.4 km of the original main stem of the Oldman River, 12 km of the Castle River and 7.5 km of the Crowsnest River. The reservoir also extends about 5.4 km into the North Fork of the Oldman River.

Construction of the Oldman River Dam began in 1987, and it was completed in 1991. The reservoir was filled initially during spring of that year and water flowed through the spillway 4 June. The reservoir was allowed to empty during summer-fall 1991 and did not refill for complete Reservoir operation during early summer 1992. The volume of the reservoir at full supply level is 490,000 dcm^3 with a surface area of approximately 1,842 ha (1,118.6 m asl). The shoreline at full supply level has a perimeter of about 104 km. The purpose of the reservoir is to regulate downstream flow by storing water during high flow periods for use during dry summer periods. The reservoir will permit 68,800 ha of dryland to be irrigated for agricultural purposes (Alberta Public Works, Supply and Services, Oldman River Dam Project Fact Sheet).

White-tailed deer (*Odocoileus virginianus*) occur in the study area, but they are not as abundant as mule deer. They have been rarely seen around the main stem of the reservoir, but have been seen in large groups downstream of the reservoir, and in the upper areas of the Oldman North Fork, the Castle River and the Crowsnest River. White-tailed deer do not appear to have an affinity for the river breaks and rugged coulee formations where mule deer predominate.

Coyotes (*Canis latrans*) are common in the Oldman reservoir basin and are likely the only important predator of mule deer, particularly fawns as has been observed in other mule deer ranges (case studies reviewed by Connolly 1981). Red fox (*Vulpes vulpes*) are also present in the study area. Seventeen coyotes were observed during the most recent winter aerial census conducted during 28 February and 1 March 1994 (Hornbeck 1994), and several observations of coyotes preying on and attempting predation on mule deer have been made.



OLDMAN RIVER RESERVOIR

MULE DEER STUDY AREA

FIGURE No. 2.0

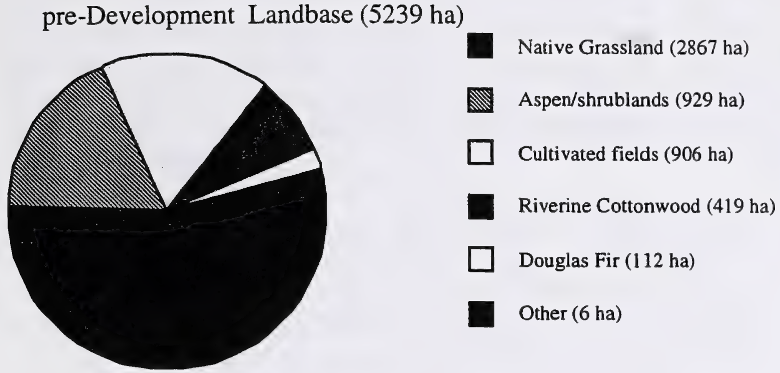
2.1 Landscape Changes with Reservoir Development

Prior to clearing and grading the river valley to the reservoir's full supply level, the river bottom and valley edges were dominated by cottonwood (*Populus balsamifera*), aspen (*Populus tremuloides*), and Douglas fir (*Pseudotsuga menziesii*) on the steeper, north-facing slopes of the river valleys. Remnant stands of these forest communities now remain above the full supply line. Dominant graminoid species include rough fescue (*Festuca scabrella*), western wheatgrass (*Agropyron smithii*), parry oat grass (*Panthonia parryi*) and june grass (*Koeleria gracilis*). Shrub communities within the river breaks and coulees are comprised primarily of saskatoon (*Amelanchier alnifolia*), chokecherry (*Prunus virginiana*), wolf willow (*Elaeagnus commutata*), skunkbrush (*Rhus trilobata*) and creeping juniper (*Juniperus horizontalis*).

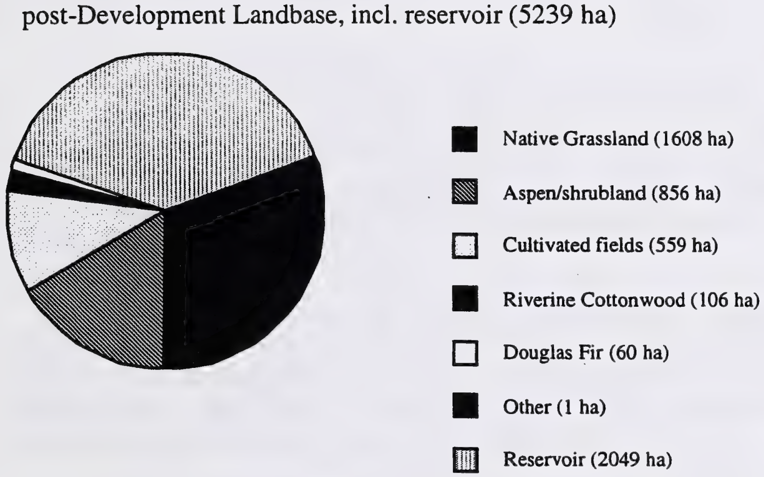
Development of the Oldman reservoir resulted in the following landscape changes. Development flooded 39% of the available habitat (Table 2.1), which involved loss of 75% of the riverine cottonwood, 46% of the Douglas Fir, 44% of the grasslands and 8% of the aspen/shrublands. The resulting mitigation land base, maintained by Alberta Environment, has a similar habitat composition as the pre-Reservoir landscape (Figure 2.1). Overall, therefore, during Reservoir development the landscape diminished in size, but it did not change substantially in the composition of its macro-habitat components.

Table 2.1 Description of Oldman River Dam project area prior to and after reservoir development. No. in brackets is percent of total.

Landscape Units (Habitat Types)	pre-Development Land base (ha) (Initial Habitat)	Post-Development Land base (ha)	
		Reservoir (Habitat removed)	Above Full Supply (Mitigation Land base)
Riverine Cottonwood	419 (8)	313	106 (3)
Native Grassland	2,867 (55)	1259	1,608 (50)
Douglas Fir	112 (2)	52	60 (2)
Aspen/ Shrubland	929 (18)	73	856 (27)
Cultivated fields	906 (17)	347	559 (18)
Other	6 (<1)	5	1 (<1)
Total	5,239 (100)	2,049	3,190 (100)



pre-Development Landbase (5239 ha)



post-Development Landbase, incl. reservoir (5239 ha)

Figure 2.1 Area (ha) of major vegetation types (habitats) in the Oldman River Dam study area prior to and after reservoir development.

2.2 Winter Temperature Patterns

Because of its increased elevation and proximity to the Rocky Mountains, the fescue ecoregion surrounding the dam experiences a climate with cooler summers and warmer winters, compared to the typical weather patterns of the Alberta prairies (Strong and Leggat 1981). The mean annual precipitation in this ecoregion is 445 mm. The mean summer temperature (May through August) is +13.8°C, while the mean winter temperature (November through February) is –3.9°C (Strong and Leggat 1992).

Winter temperature patterns during the study period were obtained for December through March from Environment Canada's Pincher Creek weather station. The resulting temperature patterns for the five winter periods (1991-92 to 1995-96) reveal a dynamic environment with annual extremes (Figure 2.2a and Figure 2.2b). The following general description of early (December), mid- (January-February) and late-winter (March) for the five consecutive years illustrates the unpredictable nature of winter weather at the Oldman River Dam:

- Winter 1991-92 = mild, mild, mild (TI = +130.1);
- Winter 1992-93 = cold, cold, moderate (TI = -765.6);
- Winter 1993-94 = moderate, cold, mild (TI = -362.0);
- Winter 1994-95 = moderate, cold, mild (TI = -335.0);and
- Winter 1995-96 = cold, cold, cold (TI = -863.4).

The common feature of every winter at the Oldman River Dam is the punctuation of cold periods with periods of thaw created by strong Chinook winds. Snow cover in the project area during winter is typically incomplete because of the Chinook influence.

Winter conditions at the Oldman River Dam project area were relatively mild during the first year of study. The winter Temperature Index [sum of average daily temperatures] was $^{+}$130.1 (Figure 2.2a, top profile). There were no long periods of cold weather at any time during winter 1991-92, and mean daily temperatures above 0°C began near the end of February 1992. The mild winter conditions of 1991-92 did not reoccur during the next four years.

The following winter of 1992-93 was relatively severe, with a Winter Temperature Index of -765.6. Winter 1992-93 can be characterized as an early winter with two relatively long periods of extreme cold. Extreme cold weather arrived in mid-December and lasted until mid-January. A second cold period lasting several weeks arrived during mid-February (Figure 2.2a, middle profile).

Winter 1993-94 at the Oldman River Dam was relatively mild overall, with a Winter Temperature Index of –362.0 (Figure 2.2a, bottom profile). Extreme cold weather did not arrive in the project area until mid-winter (January-February). Late winter (March) was mild, marked by only a few days with freezing temperatures. Winter 1994-95 marked a second consecutive winter of moderate temperatures, with a Winter Temperature Index of –335.0 (Figure 2.2b, top profile). There was no extreme cold weather in the project area during winter 1994-95; the temperature regime fluctuated repeatedly between moderately cold and thawing conditions.

Winter 1995-96 was the most severe winter that occurred during the study period with several periods of extreme cold which began in early December. (Figure 2.2b, bottom profile). The Winter Temperature Index during winter 1995-96 was –863.4.

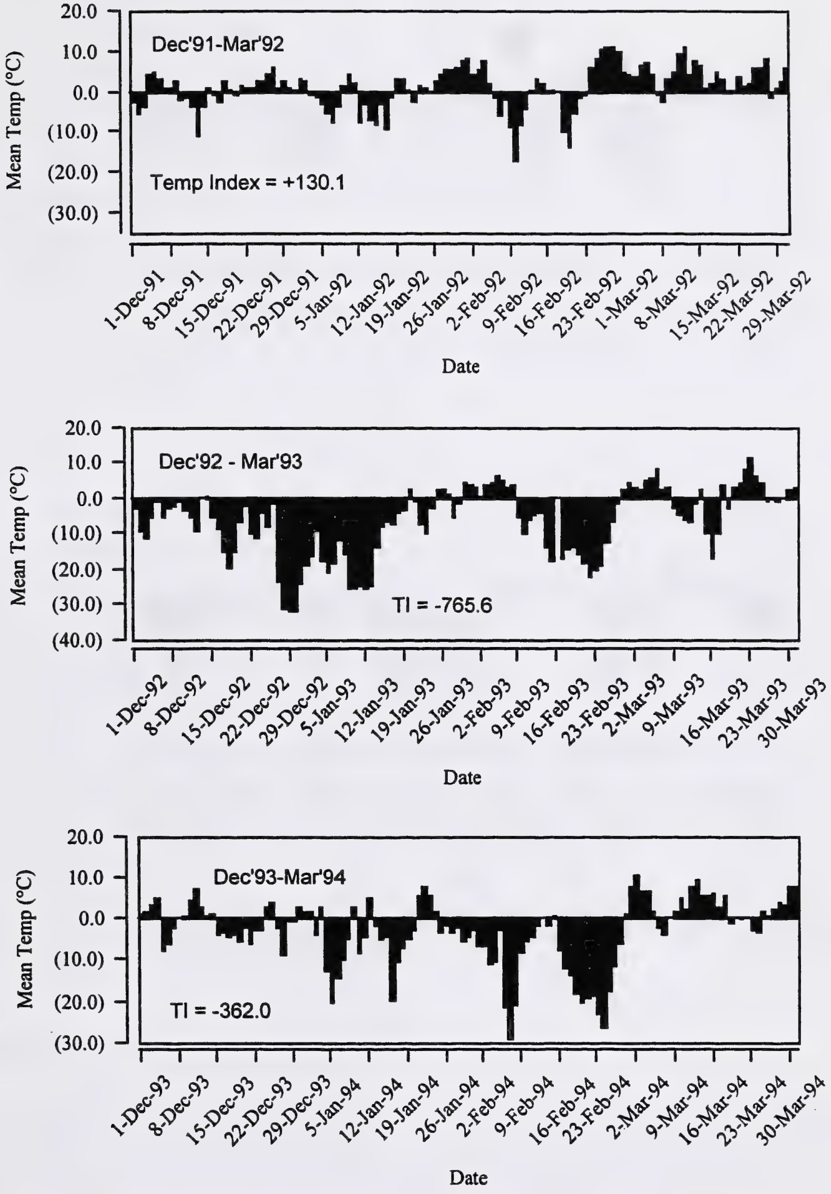
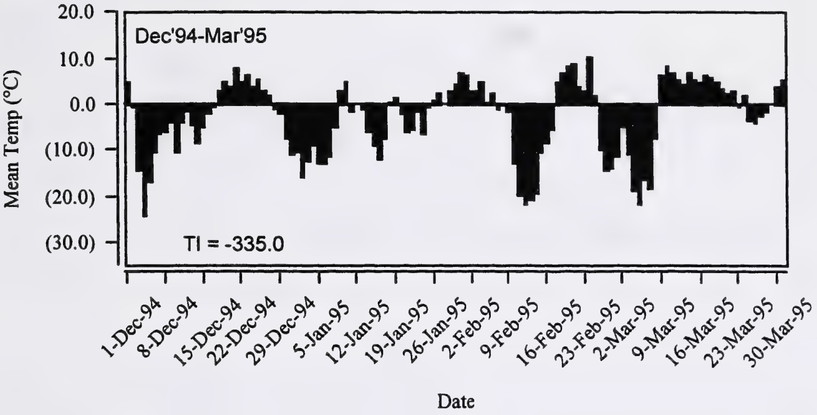


Figure 2.2a Mean daily winter temperature (December through March), 1991 to 1994 at Environment Canada's weather station, Pincher Creek.



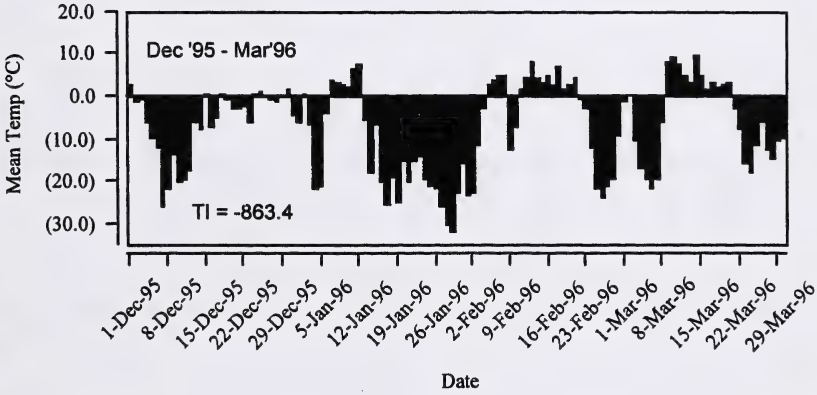


Figure 2.2b Mean daily winter temperature (December through March), 1994 to 1996 at Environment Canada's weather station, Pincher Creek.

2.3 Mule Deer Hunting Mortality

The Oldman mule deer are subjected to sport (and illegal) hunting. While the number of animals legally harvested is not known for the local population, hunter statistics are available that describe harvest levels during the past decade in the Wildlife Management Unit encompassing the Oldman River Dam project area.

Harvest of female mule deer in WMU 305 has declined dramatically, from more than 600 in 1986 to less than 200 in 1995 (Figure 2.3). In addition, the decline in total mule deer harvest has paralleled the decline in the number of hunter days.

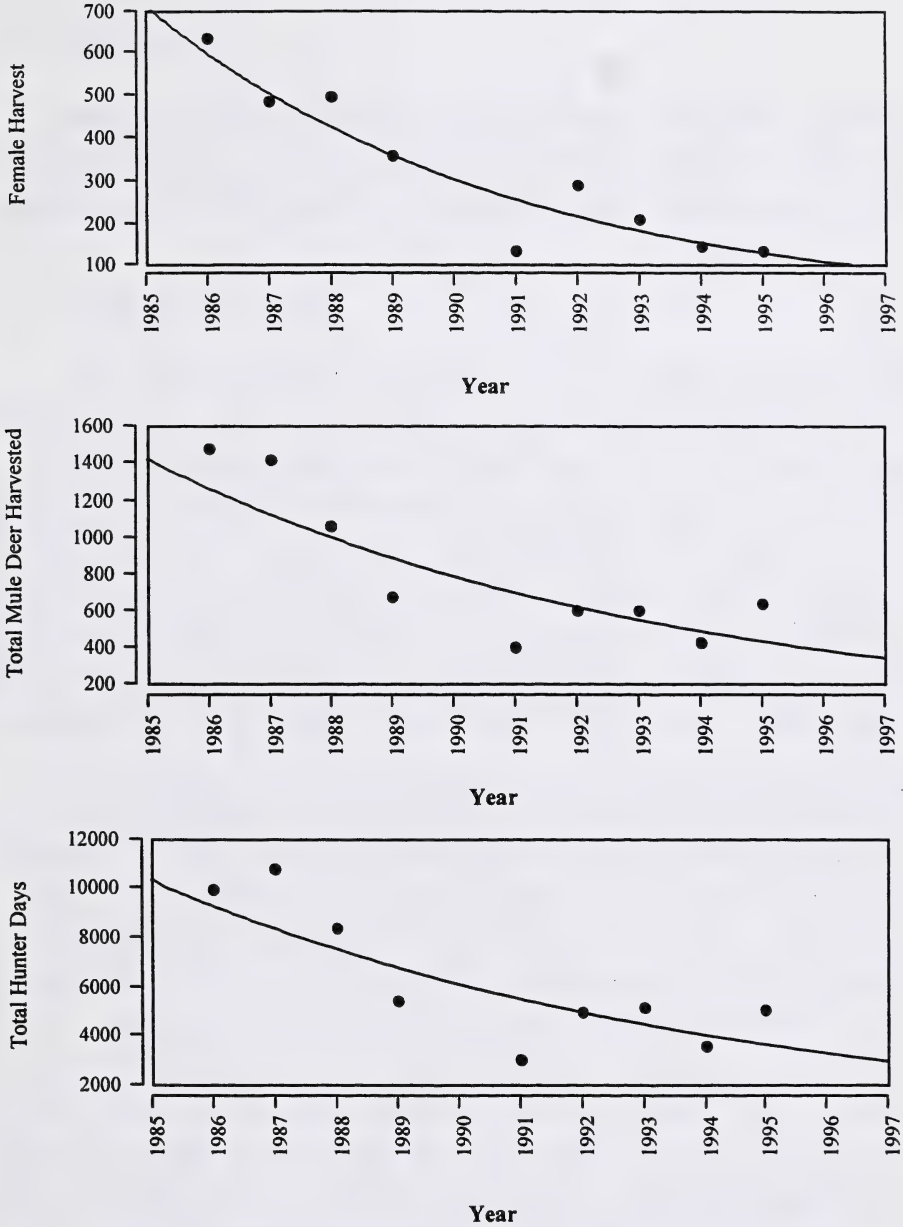


Figure 2.3 Summary of mule deer harvest statistics for the decade 1985 to 1995 in Wildlife Management Unit 305 which encompasses most of the Oldman River Dam study area (Source: Alberta Environmental Protection, Natural Resource Service).

3.0 METHODS

Methods and techniques used to study the ecological relationships of mule deer at the Oldman River Dam included: 1) winter aerial census, 2) trapping and radio-collaring, 3) intensive close-approach observations during the reproductive season, 4) blood analysis, and 5) a one-time collection of fecal pellets for food habits analysis.

3.1 Winter Aerial Census

Aerial helicopter surveys of the Oldman River Dam project area were conducted during consecutive winters 1989-90 and 1990-91, and again during consecutive winters 1992-93 and 1993-94. The surveyed area encompassed approximately 268 km^2. Aerial surveys were flown with a Bell 206B Jet Ranger helicopter, a near constant altitude of 120 m (400 ft.) above ground and a ground speed of approximately 130 km/hr (80 mph). The field of observation was approximately 200 m on each side of the helicopter. Flight lines were designed to provide 100% ground coverage. A navigator and observer occupied the front left seat accompanied by two rear-seated observers. The pilot also participated as an observer. Members of the survey crews generally had previous aerial survey experience. During the last three surveys, deer were classified to sex and age with aid of 8 x 50 mm binoculars and 45 x 60 mm spotting scopes when vantage points on the ground were used. Fawns were identified by relative size and body conformation.

Variables and techniques that could affect the aerial survey results were identified for each survey, and improvements were made over time in the way the surveys were conducted (Table 3.1). During the 1990 survey, the flight path followed contours of the Reservoir and surrounding coulee systems. During 1991, 1993 and 1994 the flight path followed the same series of linear transects oriented north to south. During 1990, rear-seat observers recorded separately from each other their observations of deer on hand-held tape recorders for later transcription. During subsequent surveys, the navigator and observer recorded all observations of deer on tape recorder provided by individual observers through the helicopter's intercom system. The objective was to maximize the time observers spent searching for and counting deer. During the last three surveys, complete turns of the helicopter were made over observed deer. Also, during the last three surveys at the discretion of the observer/navigator the helicopter landed on vantage points in the project area in order to accurately count large groups of deer from the ground. The navigator and observer plotted all wildlife observations within the reservoir component on a 1:50,000 scale aerial photo mosaic.

Reservoir clearing was nearing completion during the 1990 and 1991 surveys, but the reservoir basin had not been filled. The reservoir was full during the 1993 and 1994 winter aerial surveys. Regional survey blocks (section3.1.2) were flown with contour

lines in 1990, but the technique was replaced with parallel transects during 1991, 1993 and 1994.

Table 3.1 Variables affecting mule deer sightability during winter aerial surveys in the Oldman River Dam project area.

Potential Sources of Variation	1-3 February 1990	10-12 January 1991	1-2 February 1993	28 February-1 March 1994
Habitat Variables				
Reservoir Basin trees	Not cleared	partial cleared	all cleared	all cleared
Ground Snow Condition	Excellent	Poor	Poor	Poor
Radio-Collared Deer present	No	No	Yes	Yes
Survey Technique Variables				
No. of Observers	3	3	3	3
Observer Experience	0.3	1	1	0.67
Helicopter Height (m, agl)	120	120	120	120
Helicopter Speed (kph)	130	130	130	105-115
Survey Intensity (min./km2)	no data	1.27	1.35	1.39
Flight Pattern	Contour	Parallel	Parallel	Parallel
Turns for Observations	No	Yes	Yes	Yes
Land for Ground Counts	No	Yes	Yes	Yes

3.1.1 Accuracy of Aerial Surveys

The 1993 winter survey was the first survey that was conducted with radio-collared mule deer in the population. Marked deer in the survey area allowed an estimate of sightability for correcting population estimates. Sightability of deer was based on the proportion of marked (radio-collared) deer in the project area that were observed. The radio collars were mounted on 5 cm wide (2.5 inches) white machine belting. These collars are highly visible to observers in the helicopter. The helicopter survey crew did not have any prior knowledge of the total number of marked deer or their precise locations under each census. Marked deer were relocated independently by a ground crew during aerial surveys.

Expanded Population Estimate

For population counts in 1993 and 1994 it was possible to estimate the population using a capture – recapture model. The ratio estimator (Modified Peterson/ Lincoln Index

ratio estimator) for mark-recapture studies was used to generate an expanded population estimate (Pollock 1981):

$$N \text{ (expanded population estimate)} = \frac{(n_1 + 1) * (n_2 + 1)}{m_2 + 1}$$

$$\text{Variance of the estimate} = \frac{(n_1 + 1) * (n_2 + 1) * (n_1 - m_2) * (n_2 - m_2)}{(m_2 + 1)^2 * (m_2 + 2)}$$

n_1 = no. of marked (radio-collared) deer in the survey area;
n_2 = total no. of deer observed during the survey; and
m_2 = no. of radio-collared deer observed during the survey.

3.1.2 Regional Aerial Surveys

In conjunction with aerial surveys of the Oldman River Dam project area, mule deer were counted in nine regional survey blocks located in foothills habitat south and west of the Oldman reservoir basin. Regional survey blocks were designed by Provincial wildlife biologists for monitoring trends in deer numbers in order to achieve provincial management goals. The nine regional survey blocks varied in size from 5.8 km^2 to 18.1 km^2, for a combined area of 92.5 km^2 (Hornbeck 1994). These blocks were located within the montane ecoregion of southwestern Alberta, dominated by forests of lodgepole pine (*Pinus contorta*) mixed with stands of Douglas Fir. Individual blocks were selected as representative "key" winter ranges. Mule deer counts from regional blocks were available from 1978 and 1980 prior to surveys conducted in these blocks under the auspices of the Oldman project. For trend analysis, deer counts in these blocks were standardized to density of deer per 100 km^2.

Regional surveys for mule deer were conducted to assist with the interpretation of subsequent changes that were expected to occur within the Oldman River Dam project area. The regional survey blocks were designed as a control for comparison with observed changes in mule deer populations around the reservoir.

3.2 Capture and Radio-collaring

Mule deer were captured during mid and late winter using modified Clover traps, approximately 85 cm wide, 120 cm tall, and 180 cm long. The trap frame was made of 2.5 cm (1") galvanized pipe, and the door opening was 100 cm (± 10 cm) high. A nylon monofilament trip line was placed about 20 cm above the ground across the width of the trap. Nine different traps were operated in various locations around the reservoir. The traps were re-fitted with nylon netting after the initial year using chain link fence. Experience showed that chain link fence was injuring some deer.

The Clover traps proved effective, although captures appeared to be somewhat biased toward adult females and fawns (Figure 3.2). Overall, 115 mule deer were captured, comprised of 82 individuals. From this sample, 31 adults were fitted with radio-collars (Appendix Table 2 - List of captured deer). The objective was to fit radios to adult females, however, a few males were also radio-collared.

Handling Procedure

Traps were set in the late afternoon or early evening, and checked the following morning. Deer in traps were physically subdued inside the trap; deer were held, blindfolded and then four legs hog-tied with 1/4" nylon rope. Deer were then weighed in a sling beneath a dial scale attached at the center of a beam. Standard body measurements were recorded (see Hornbeck and Balagus 1992) (Appendix Table 3 - physical measurements). The tooth row of most deer older than fawns was inspected for irruption of the third molar (indicating adult age class), and was inspected for tooth wear as an indication of approximate age. Each deer received a numbered dangle tag in the right ear (black letters on white tag) and small metal tag in left ear. Long-life (48 months) battery powered, mortality sensitive, radio collars manufactured by Lotek (Aurora, Ontario) were fitted to all adult deer. A few drops of blood from each deer were collected on a paper towel and submitted to the Provincial Forensic Laboratory. Blood samples were analyzed for evidence of possible hybridization between mule deer and white-tailed deer (B. McClymont, Forensic scientist, Alberta Environmental Protection, Fish and Wildlife Service).

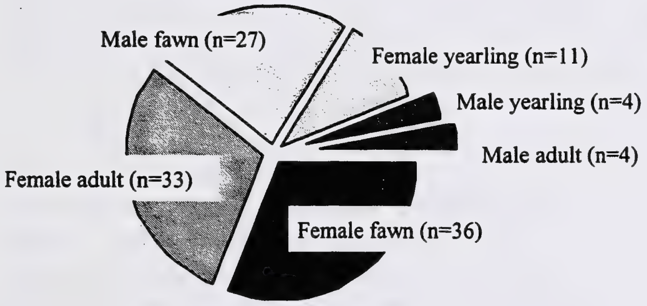


Figure 3.2. Percent composition (by age and sex class) of mule deer captured during winter in Clover Traps at the Oldman River Dam project area, 1992 to 1994 and 1996.

3.3 Movements and Home Range

Relocations of mule deer were obtained by ground triangulations or by close approach. During all years, relocations were intensive during the fawning season as adult

females were kept under almost daily observation. Outside the fawning season, relocations of deer were sporadic, generally about once or twice a month (Appendix Table 4 - number of relocations). Relocations were recorded to the nearest 100 m with UTM grid references interpreted from 1:50,000 scale topographic maps. Distances between successive relocations were calculated on a Microsoft Excel™ spreadsheet based on geometric relationships of easting and northing coordinates. The study area was bisected by two map sheets with different grid zones (11U and 12U). Relocations for deer movements spanning the two grid zones were converted to a common reference frame for accurate geo-referencing (L. Giles, Axys Environmental Consulting Ltd., 31 October 1997).

Relocation coordinates were analyzed by McPaal™ software to generate minimum convex polygon home ranges (Stuwe, M. 1993. Conservation and Research Center, National Zoological Park, Smithsonian Institution).

3.4 Productivity

An attempt was made to identify birth of fawns during each reproductive season by relocating on a regular schedule all radio-collared females. A close approach technique from the ground was used while avoiding disturbance to the target deer. A close approach was necessary because mule deer are "classic hiders" (Geist 1981), and females only visit neonates occasionally for brief periods for nursing. White *et al.* (1972) observed that white-tailed deer when not attending fawns were often observed feeding or resting from 50 yards to a mile away in the company of other deer. Our experience indicates the same is true for mule deer at the Oldman River Dam. Visual contact with each deer was attempted during each relocation in order to determine the location and date of fawn birth, and number of fawns born to each female.

When radio-collared deer were in open habitat (grasslands or low shrub habitat), deer were observed continuously for an extended period (≥ 2 hours). A spotting scope was used to determine by visual confirmation or by behavioral clues if fawns were present. When deer were concealed in tall shrub or forest, the biologist maneuvered for a visual confirmation of a fawn. If a deer was startled, a search was conducted within the immediate area for a concealed fawn. The habitat type for each neonate was recorded, and notes were made regarding their agility. When fawns were more than a day old, their birth dates were estimated by backdating based on their agility. Fawns that did not follow the adult when disturbed but remained bedded were considered to be 1-2 days old. Fawns that readily followed the adult or ran from cover when disturbed were considered 3-4 days old. To investigate birth site fidelity, the distance between newborn fawns between years was calculated as the straight-line distance.

The data on fawn production in 1992 was incomplete. Many of the available radio-collared females were not observed sufficiently to know whether fawns were born.

This was also true to some extent in all years. The incomplete data is an acknowledged source of bias in attempting to identify peak parturition date and overall productivity.

3.5 Annual Mortality

An estimate of percent annual mortality was calculated using the following model (Gasaway *et al.* 1983):

Percent annual mortality $= (a \div b) \times 100$

$a =$ number of mortalities tallied among radio-collared deer within a specific period;
$b =$ estimated number of collared deer-periods calculated as

$b = (c \times d) \div e$

$c =$ mean no. of months collars transmitting, excluding dead deer;
$d =$ total number of radio-collared deer, including deer that died; and
$e =$ time interval that corresponds to deer-period.

3.6 Food Habits

During initial trapping efforts in winter 1991-92, mule deer pellets were collected for microhistological analysis of food habits. Five pellets were collected from three different fecal groups in each of five different regions of the project area:

1. North Fork of the Oldman River;
2. Crowsnest River;
3. Castle River;
4 Mainstem of the Reservoir; and
5. downstream of the Dam.

Pellets from each fecal group were combined to a single sample and sent for analysis to the AAFAB Composition Analysis Laboratory in Fort Collins, Colorado.

4.0 RESULTS AND DISCUSSION

4.1 Physical Size and Body Condition

Body weights and measurements were recorded for 83 mule deer captured at the Oldman River Dam project area during three different mid-winter periods (Appendix Table 3). Deer #39 was captured as a fawn, then two years later was captured as an adult. No measurements were recorded from the deer captured during winter 1992-93. While comparison of body characteristics among sex and age groups is limited by sample sizes for yearling and adult males, the data represents a unique contribution to *Odocoileus hemionus* from southwestern Alberta.

4.1.1 Weight

Female fawns in mid-winter weighed less (35.6 kg) than males of the same age (38.8 kg) (Table 4.1.1). The difference of 3.2 kg was significant (Student's t = -2.655; $p < 0.01$). Adult females (including yearlings) averaged 65.6 kg during mid-winter, 30 kg heavier than female fawns. Although sample sizes for the female yearling class were small (n = 5), the average of 44 kg was 21.3 kg less than adult females.

Few yearling or adult males were captured at the Oldman River Dam (n = 4 and 3, respectively), precluding statistically meaningful descriptions of these age classes (Table 4.1.1). However, while heavier than yearling females, yearling males appear not to be as heavy as adult females, a difference of about 9.4 kg. To the extent of the limited data, adult males were heavier than adult females, a difference of more than 7 kg. Compared to some of the published literature, these weights are somewhat lighter than expected (Stelfox 1993).

4.1.2 Body Measurements

Seven standard body measurements were recorded from mule deer, each a different aspect of their physical development (Table 4.1.1). Shoulder height (cm) as a proxy to stature, was summarized to illustrate the differences among sex and age groups (Figure 4.1). Data from other body measurements are provided in Appendix Table 3. Unlike body weight, differences in shoulder height between female and male fawns (79.3 cm and 82.4 cm, respectively) was relatively small and were not significant (Student's t = -1.548; $p > 0.05$). As expected, male yearlings tended to be larger than females (92.2 cm and 82.6 cm, respectively), but have about the same stature as adult females (93.2 cm). Adult males tended to be considerably larger in stature than adult females, although the relatively small sample reveals a large amount of variation. While shoulder height of the Oldman mule deer compares favorably to published literature (Anderson and Wallmo 1984), chest heights of deer at the Oldman are lower than expected (Stelfox 1993).

Table 4.1.1 Physical measurements (cm) of mule deer (mean ± SE) captured during February-March 1992, January-February 1994 and January-February 1996 at the Oldman River Dam project area, southwestern Alberta. (Number in brackets is sample size).

	Female			Male		
Physical Measurement	Fawn (<9 mo.)	Yearling (10-21 mo.)	Adult and Yearling (<21 mo.)	Fawn (<9 mo.)	Yearling (10-21 mo.)	Adult (<32 mo.)
Live Weight (kg)	35.6±0.8 (21)	44.3±4.3 (5)	65.6±1.2 (26)	38.8±0.9 (24)	56.2±3.3 (4)	72.6±2.5 (3)
Chest Girth	79.1±0.8 (21)	86.0±3.4 (5)	101.2±1.9 (25)	84.0±1.1 (23)	108.1±10.1 (4)	107.3±1.3 (3)
Chest Height	49.8±0.8 (21)	50.2±2.7 (5)	54.1±1.0 (25)	48.7±1.0 (24)	54.8±3.2 (4)	54.3±2.7 (3)
Shoulder Height	79.3±1.8 (21)	82.6±2.2 (5)	93.2±1.1 (26)	82.4±1.0 (24)	92.2±2.7 (4)	101.7±6.7 (3)
Tarsal Bone Lgth	38.5±0.3 (21)	38.7±2.3 (5)	42.5±0.3 (26)	39.8±0.4 (24)	44.6±0.9 (4)	45.5±0.8 (3)
Tarsal Gland Lgth	13.1±0.8 (5)	13.0 (1)	14.8±0.5 (10)	11.6±0.4 (12)	12.2±0.2 (2)	15.2±1.1 (3)
Head Length	24.8±0.3 (21)	25.2±0.5 (5)	30.7±0.5 (26)	25.4±0.3 (24)	29.5±0.5 (4)	29.2±2.6 (3)

4.1.3 Body Condition

An effort was made during capture to assess overall body condition by estimating body fat reserves. In almost all cases, mule deer of all age and sex classes were judged to be in either Good or Medium body condition (Table 4.1.2). Winter ticks (*Dermacentor albipictus*) on the body were noticed during capture February - March 1992, although the burden appeared to be relatively small with an average of a few ticks per deer (see Appendix Table 2). The prevalence of winter ticks on Oldman mule deer did not increase during the period 1992 to 1996. Few physical injuries were noted with trapped deer, although torn ears were relatively common and presumably were inflicted by barbed wire fences.

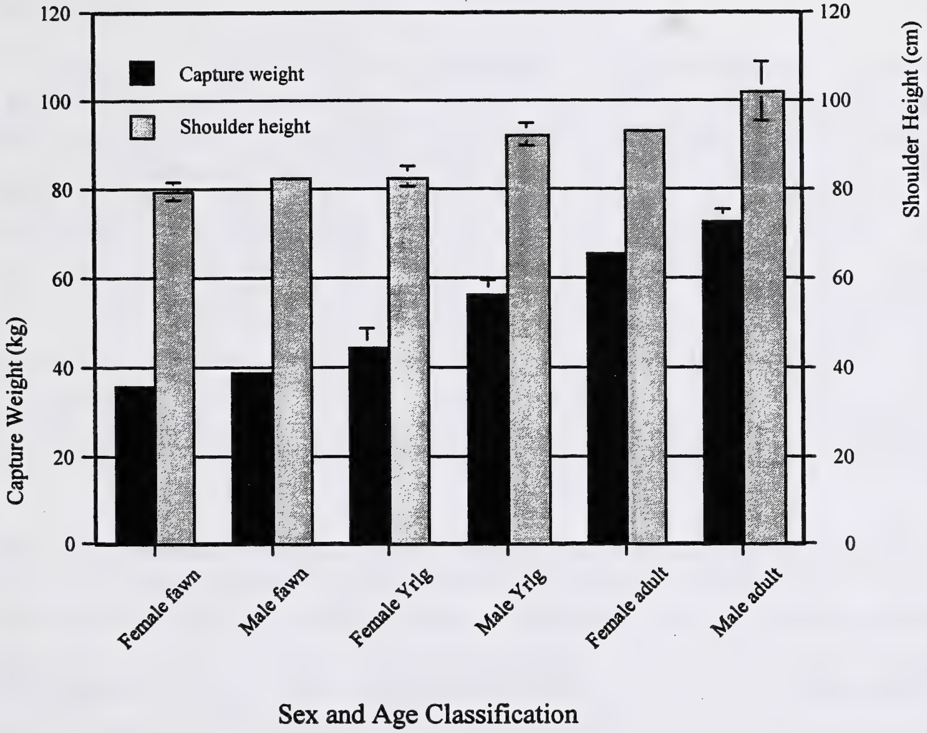


Figure 4.1 Weight (kg ± SE) and shoulder height (cm ± SE) of captured mule deer at the Oldman River Dam project area during mid-winter 1991-92, 1993-94 and 1995-96.

Table 4.1.2 Percent of deer in various body condition classes[1] during each trapping effort at the Oldman River Dam project area, winter 1991-92, winter 1993-94 and winter 1995-96.

February - March 1992 (n = 50 deer)				January - February 1994 (n = 20 deer)				January - February 1996 (n = 11 deer)			
Good	Med.	Fair	Poor	Good	Med.	Fair	Poor	Good	Med.	Fair	Poor
86	6	4	4	65	15	15	5	91	9	0	0

[1] *Condition class was based on the subjective assessment of the amount of body fat reserves.*

4.1.4 Hybridization

Blood tests suggested that some hybridization with white-tailed deer is occurring in the Oldman mule deer (Table 4.1.3). Occasional hybrids have been reported from other areas of Alberta for many years (Wishart 1980). Hybrids are generally thought to represent the offspring of a mule deer female and a white-tailed male. The male 50:50 hybrids are sterile, but the females are fertile (Stelfox 1993). At this time, the significance of these findings is not clear, although Geist (1990) concludes that hybrids "are hardly functional deer." The large amount of mule deer habitat that has been removed at the Oldman River Dam may have an effect over a longer period of time. The effect may be an increasing overlap of these two closely related species and hence increasing the incidence of hybridization. The kinds of management steps that can be taken are discussed by Geist (1990), but all are difficult decisions and none very palatable. One approach may be to adjust hunting regulations on mule deer range that reduce the number of white-tailed males while foregoing all hunting of mule deer males.

Table 4.1.3 Hybridization of Oldman river Dam mule deer with white-tailed deer. Blood samples were tested by the forensic lab, Alberta Natural Resources Service, Edmonton.

Capture Year Blood Collected	No. of Blood Samples Submitted for Analysis	No. of Whitetail Hybrids Identified
1991-92	35	3 [female fawns #37, #43 and adult female #45]
1993-94	19	0
1995-96	12	0

4.2 Population Change

Various attempts have been made to enumerate mule deer in the Oldman River Dam project area. Beginning in the mid-1980's, ground-based visual searches were conducted. Results of these early efforts suggested that the number of mule deer in the project area changed seasonally, with winter being the season when deer were most abundant. As indicated in the Introduction, an early attempt at a population estimate identified about 350 to 400 mule deer in the project area. This estimate, however, was without bounds on its error, and at best represented only a minimum number.

Results of the current study, with complete aerial counts and use of mark-recapture ratios, has yielded estimates of considerably larger numbers of mule deer (Table 4.2.1). The current study has also provided information on population change during the immediate post-development years of reservoir construction. Without correction for sightability, the minimum mule deer population in the project area apparently increased from at least 554 deer in 1989-90 to 739 mule deer in 1993-94. The two intervening years of winter census provided estimates between these values, suggesting the possibility of an increasing population. However, these estimates cannot be accepted as population estimates without further analysis.

Table 4.2.1 Number of mule deer observed during helicopter winter aerial surveys of the Oldman River Dam project area.

Reservoir Segment	1-3 February 1990	10-12 January 1991	1-3 February 1993	28 February - 1 March 1994
Oldman Main Stem	145	177	353	432[1]
Oldman North Fork	143	136	147	126
Castle River	137	166	52	69
Crowsnest River	129	73	138	112
Total no. of Deer	554	552	690	739

[1] *Survey of the Castle River was incomplete, not flown south of Full Supply Line.*

4.2.1 Evaluation of Aerial Surveys

As discussed in Methods, the aerial survey technique 'evolved' during the four surveys conducted between 1990 and 1994. While a concerted attempt was made to hold technical parameters of each survey constant (number and experience of observers, helicopter speed and height above ground, and survey intensity) (Table 3.1), other factors were introduced over time that may have influenced the deer count. Most notably, the parallel flight pattern, the practice of circling the helicopter for each deer observation, and the practice of landing the helicopter to obtain ground counts were introduced in 1991 and carried forward in subsequent years. These improvements could have yielded higher total counts than without the additional effort. Another factor that changed was the amount of cleared forest within the Reservoir basin. Clearing of treed areas was not completed until after the 1991 winter survey, the result was fewer treed habitats in the

project area during the later two surveys compared to the earlier two surveys. A complete ground cover of about 17 cm of new snow accompanied the 1990 survey. Snowfall did not precede subsequent surveys with the general result that surveys in 1991, 1993 and 1994 were conducted under relatively poor conditions of patchy and old snow cover, which can be expected to yield low counts.

A marked feature of the aerial survey counts over time was the close agreement in total deer counts between consecutive annual surveys, with a comparatively large increase in deer observed between 1991 and 1993. This increase in deer observed does not correspond to the introduction of 'improvements' that have been discussed. For example, close agreement in total deer observed occurred between 1990 and 1991 despite several obvious "improvements." The most notable improvement was the exchange of the contour flight pattern for a parallel pattern in 1991. Other improvements in 1991 were the introduction of frequent turns with the helicopter allowing additional time to count groups of deer, and the fact that large groups of deer were counted from selected vantage points by landing the helicopter. Mitigating against the possibility of a higher total count in 1991 compared to 1990 was the factor of poor snow conditions in 1991. Despite these changes in survey technique between 1990 and 1991, the total deer count among segments of the reservoir remained virtually identical between years.

The large increase in total deer numbers in the project area between 1991 and 1993 was coincident with the introduction of radio-collared deer into the population. The appearance of radio-collared deer in the project area also corresponded to a small increase in aerial survey intensity. Knowing that a sightability estimate was possible for the first time during 1993 may have heightened the proficiency of the survey crew.

Considering the evidence, and conditions of the population surveys as conducted, the conclusion is that the mule deer population has increased over the course of the five years that they were observed.

4.2.2 Expanded Population Estimate

Radio-collared deer were present in the project area during the 1993 and 1994 winter aerial surveys. Radio-collared deer provided an additional opportunity for further analysis of the population counts. The number of radio-collared deer observed during these winter aerial surveys, compared to the number with collars in the surveyed area, provided a measure of aerial survey accuracy. The percentage of radio-collared deer observed reflects the proportion of the entire population observed. Assumptions for applying the mark-recapture ratio technique to expand the count to an estimate are:

- a reasonable proportion of the population is marked, generally the larger the proportion of marked animals the better; and,
- there is a random intermixing of marked deer with unmarked deer, and that each marked deer had the same chance of being observed.

The proportion of marked deer in the 1993 population was about 2% (16 marked deer within an observed population of at least 690 deer), and about 3% (23 marked deer within an observed population of about 739 deer) in 1994. During surveys it was also observed that marked deer were not randomly distributed within the survey area; some radio-collared deer closely associated with each other in specific areas. This suggests that not all radio-collared deer had an equal chance of being observed. These limitations suggest that caution is needed when applying the mark-recapture ratio as a correction for the observed population estimates. However, the sightability of collared deer suggests that the actual deer population was larger than observed. Ten of the 16 radio-collared deer within the survey area were observed during 1993 (sightability = 62%), and 17 of 23 radio-collared deer were observed during 1994 (sightability = 74%) (Table 4.2.2).

Table 4.2.2 Radio-collared deer observed during helicopter winter aerial surveys of the Oldman River Dam project area.

	1 - 3 February 1993	28 February - 1 March 1994
Total mule deer counted (n_2)	690	739
No. of collared deer available (n_1)	16	23
No. Collared deer observed (m_2)	10	17
Sightability of mule deer	0.625	0.739

Using the Petersen/ Lincoln Index (ratio estimator: see Methods), it is possible to estimate with confidence that the population of mule deer at the Oldman River Dam during 1993 and 1994 was:

95% Confidence Interval, the mule deer population was:

$$1993_{(0.95)} = 712 < \mathbf{1069} < 1426$$

$$1994_{(0.95)} = 768 < \mathbf{988} < 1208.$$

90% Confidence Interval, the deer mule population was:

$$1993_{(0.90)} = 770 < \mathbf{1069} < 1368$$

$$1994_{(0.90)} = 804 < \mathbf{988} < 1172.$$

4.2.3 Age and Sex Classification

Classified counts from winter aerial surveys suggest that recruitment of fawns into the population was variable year to year (Table 4.2.3). Observations of years of relatively high recruitment supports the possibility of a population increase as indicated by the aerial survey counts (see next section).

Table 4.2.3 Age and sex classification of mule deer observed during mid-winter aerial surveys of the Oldman River Dam project area. Data only from deer groups that were completely classified.

Survey Date	Adult Female	Fawn	Yearling Male	Adult Male	Total
February 1990	--- no data on sex/age was collected during this survey ---				
January 1991	290	143	3	16	536
	Fawns:100 Females = 40:100		Males:100 Females = 7:100		
February 1993	134	67	3	2	206
	Fawns:100 Females = 50:100		Males:100 Females = 4:100		
February-March 1994	278	160	0	10	448
	Fawns:100 Females = 58:100		Males:100 Females = 4:100		

4.2.4 Population Size and Trend

Four winter aerial surveys over five years do not provide a coherent dataset that could be readily used to estimate the population trend. This is because it was not possible to develop expanded population estimates from the early surveys (i.e., there were no marked mule deer in the population during the 1989-90 or 1990-91 counts). However, the early data can be "adjusted" using the sightability factor that emerged in later surveys to generate comparable data. Assuming the most optimistic 1994 sightability of 0.739, the 1990 and 1991 counts have been "adjusted" to 699 deer and 696 deer, respectively. Combining these corrected estimates with the expanded population estimates, the population trend shows an increase of about 11% annually (Figure 4.2.1).

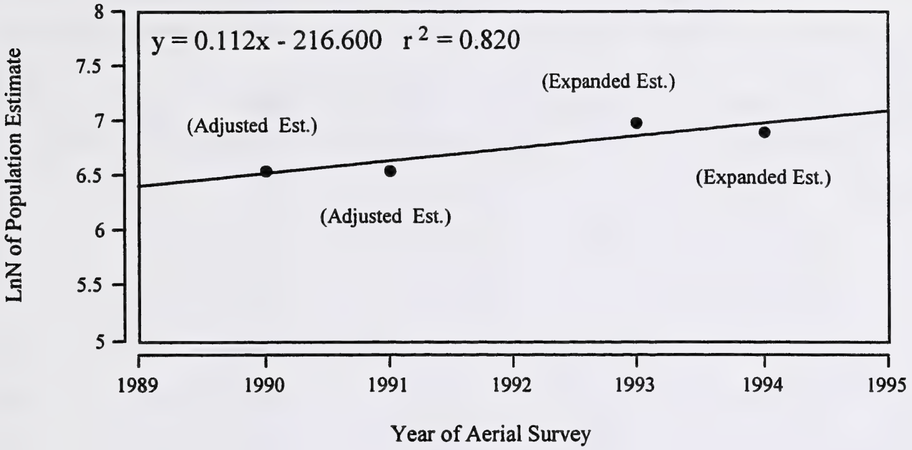


Figure 4.2.1 Regression analysis of mule deer population trend at the Oldman River Dam project area, 1990 to 1994.

4.3 Regional Population Change

Regional mule deer counts were conducted with the same aerial census technique described above for the Oldman project area, however, radio-collared deer were not available in foothills control blocks to provide "adjusted" estimates. Therefore, regional mule deer counts are presented as minimum and are to be interpreted with caution.

Winter counts of mule deer within nine different regional foothills control blocks apparently declined since the late 1970's (Table 4.3). This trend in declining numbers appears to have been sustained since Provincial biologists began collecting this information (Figure 4.3). The regional information contrasts with the deer population trend observed within the Oldman River Dam project area. There is no readily available explanation why mule deer have maintained their numbers in the developed landscape of the Oldman River Dam project area despite habitat losses, while declining in relatively undisturbed habitats in the adjacent foothills.

One possible explanation for the contrasting population trends is that hunting pressure on mule deer in the foothills has depressed the regional population. The provincial hunting statistics for Wildlife Management Unit 305, however, are not consistent with this explanation. During the past decade, hunter-days, total mule deer harvest and harvest of female mule deer have declined steadily (see Figure 2.3). However, not all foothill control blocks were in WMU 305, some others were in WMU 302, 306 and 310. Harvest statistics for WMU 302 show similar tends in deer harvest

Table 4.3. Number of mule deer observed during mid-winter aerial surveys of Foothills Control Blocks, southwestern Alberta, 1978 to 1994.

Survey Block	1978	1980	1990	1991	1993	1994
FH 1	262	73	67	48	13	20
FH 2	316	255	201	269	128	113
FH 4	65	39	11	n/s[1]	0	0
FH 9	51	n/s	26	40	8	11
FH 10	25	39	36	9	49	3
FH 12	39	n/s	14	8	2	0
FH 13	35	n/s	39	6	0	0
FH 14	n/s	32	4	0	0	0
FH 15	n/s	18	5	n/s	4	0
Total	793	456	403	380	204	147

[1] *n/s = indicated aerial survey blocks that were not surveyed in a given year.*

parallel with WMU 305. Hunting statistics clearly indicate harvest pressure on mule deer in the Oldman River Dam project area has declined steadily during the past decade. It may be that the agricultural land base surrounding the reservoir is promoting the security and welfare of Oldman River Dam mule deer. Hunting of mule deer has been closed in the Oldman Dam Provincial Recreation Area since 1994 (see Figure 2.0). This hunting closure was implemented, however, after the population trend had been established.

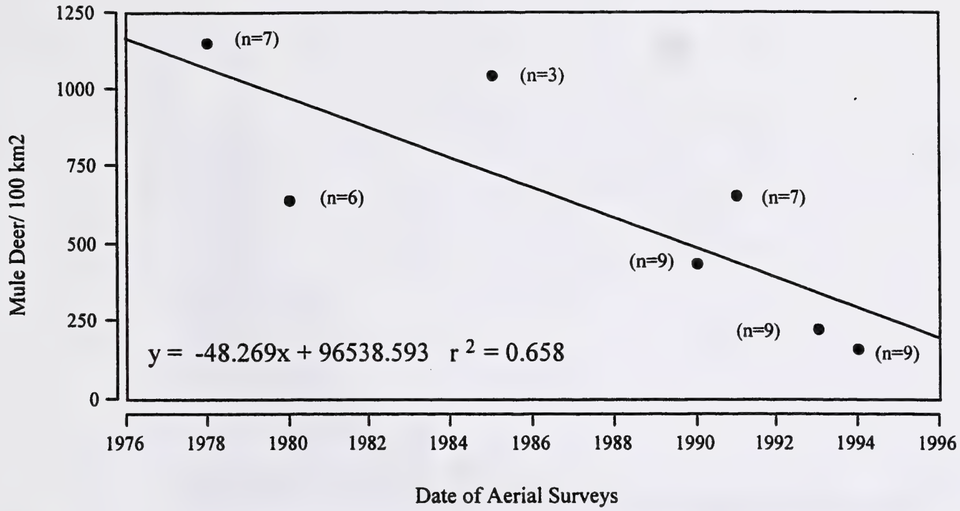


Figure 4.3. Regional mule deer population estimates based on mid-winter aerial surveys of regional survey blocks in the foothills adjacent to the Oldman River Dam project area.

4.4 Movement Patterns and Home Range

Thirty-one (31) mule deer were radio-collared during this study (Appendix Table 7.2). The majority of deer were adult females, although three radio-collars were attached to males (#57, #65, and #Y13). Relocations of mule deer were not obtained on a planned or sustained schedule throughout the study. Some deer died shortly after radio-collaring (see mortality section below), and at the time of this report few relocations had been obtained from mule deer trapped in the 1995-96 winter season. Collectively, 95% of the relocations were obtained from 22 radio-collared deer, largely from deer collared in the 1991-92 winter trapping season.

Because emphasis during this study had been placed on relocating deer during the reproductive season, the database of movements is weighted toward movement behavior in that season. However, for identifying seasonal movements within a given year, several to a maximum of 12 relocations were obtained for most deer during winter (defined as December to March) (Appendix Table 7.4). These winter relocations were used to define seasonal and annual range use.

Given the biases in the movement data, the distance between successive relocations for all radio-collared deer revealed that the majority of deer movements were highly localized, almost entirely <3 km (Figure 4.4). The non-migratory, sedentary behavior of adult female mule deer in the Oldman River Dam project area underlies this pattern of movement. One adult female dispersed during the 4th year of study (1995),

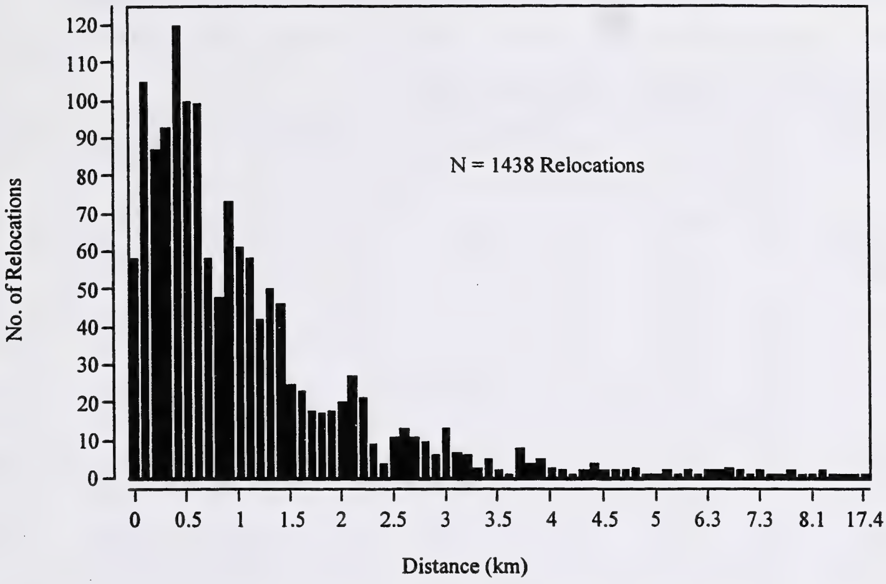


Figure 4.4 **Distribution of distance between successive relocations for radio-collared mule deer at the Oldman River Dam project area, 1992 to 1996.**

moving about 16 km from the project area where she subsequently dropped her fawn. No other radio-collared female mule deer changed location of annual home ranges during this study.

The three male mule deer that were radio-collared during this study provided few relocations. Consequently, little information has been obtained on the movements of male deer. The males collared in 1994 died within 1.27 years (road killed) and 0.74 years (harvested), respectively. Mortality on these two males occurred within 7.91 km and 1.59 km from their respective trap sites. Male #Y13 yielded only 6 relocations from time of capture (27 February 1996) and was last observed 22 May 1996, 5.1 km from the trap site.

The non-migratory behavior of adult female mule deer at the Oldman River Dam is illustrated by a number of home range statistics (Table 4.4.1). In addition to the minimum convex polygon (MCP), home range movements are described by mean distance between successive relocations, maximum distance between successive relocations and maximum distance along both *x*-axis (east-west) and *y*-axis (north-south) of the multi-annual home range.

Table 4.4.1 Multi-annual home range statistics from radio-collared adult mule deer at the Oldman River Dam project area. Most radio-collared deer were female (F); 3 were male (M).

			Movement Patterns		Home Range Dimensions		
Deer No., Sex (radio freq.)	Monitoring Period (Capture to last Reloc)	No. Reloc.	Mean[1] Dist.(km)	Max[2] Dist.(km)	X-Axis[3]	Y-Axis[4]	MCP[5] (km^2)
6F (148.731)	6 Feb '92 to 30 Jun '95	55	1.1	7.2	8.2	3.3	12.86
	26 Jan '95 - 26 Nov '95	17	2.1	15.8	11.5	10.9	1yr = 37.1
7F (149.921)	10 Feb '92 to 14 July '94	61	1.1	4.8	9.6	5.5	25.57
8F (149.951)	11 Feb '92 to 21 Oct '96	111	0.6	3.8	4.8	2.3	6.76
13F (150.095)	13 Feb '92 to 3 Mar '95	60	1.2	4.7	7.2	5.9	22.70
16F (150.114)	14 Feb '92 to 21 May '96	68	2.1	9.2	11.6	5.7	35.08
22F (150.014)	27 Feb'92 to 6 Apr '95	76	0.7	3.2	3.4	4.5	8.73
25F (150.045)	28 Feb '92 to 20 Jun '96	76	0.8	3.3	3.0	4.7	9.17
26F (150.055)	28 Feb '92 to 23 Oct '95	88	0.9	4.3	7.3	3.9	16.21
28F (148.565)	4 Mar '92 to 22 Jul '94	44	1.1	3.0	3.3	5.2	10.69
29F (150.064)	4 Mar '92 to 23 Jan '95	54	1.0	3.7	3.6	3.1	7.76
35F (150.073)	5 Mar '92 to 29 Jun '95	96	1.0	5.1	7.5	4.4	14.80
38F (150.083)	4 Mar '92 to 21 Oct '96	92	0.8	2.8	1.9	3.5	4.96
39F (150.263)	6 Mar '92 to 15 Jun '96	45	1.8	7.3	7.8	3.8	23.56
42F (150.104)	7 Mar '92 to 20 Sep '94	64	1.7	8.1	10.1	5.3	36.96
45F (150.124)	10 Mar '92 to 16 Nov '92	34	1.1	4.8	6.5	3.3	1 yr = 9.08
46F (150.156)	11 Mar '92 to 6 Nov '93	53	0.8	3.2	2.6	3.8	5.24
47F (150.164)	11 Mar '92 to 17 Jun '96	110	1.1	3.8	4.6	4.0	12.18
51F (150.205)	26 Jan '94 to 21 Oct '96	56	0.8	3.1	4.5	4.4	10.26
54F (150.555)	27 Jan '94 to 30 Jun '94	12	2.3	9.2	12.0	2.9	1 yr = 17.62
55F (150.303)	27 Jan '94 to 19 Nov '94	11	1.8	4.5	5.0	3.9	1 yr = 12.52
57Male (150.023)	2 Feb '94 to 11 May '95	11	2.8	4.8	5.0	3.8	1 y = 10.26
59F (150.295)	4 Feb '94 to 21 Oct '96	35	1.5	7.3	5.6	6.1	13.89
60F (150.314)	4 Feb '94 to 26 Oct '94	8	0.9	1.9	2.2	1.9	1 yr = 1.89
62F (150.194)	9 Feb '94 to 21 Jun '96	28	1.1	4.4	4.0	5.1	9.07
65Male (150.005)	11 Feb '94 to 8 Nov '94	8	4.1	5.9	6.1	5.1	1 yr = 13.61
70F (148.565)	19 Jan '96 to 14 Jun '96	8	0.6	1.7	2.0	0.1	1 yr = 0.30
Y4F (150.184)	1 Dec '92 to 21 Oct '96	31	1.3	5.0	6.4	4.5	14.12
Y8F (150.036)	1 Dec '92 to 24 Jun '96	41	1.1	3.0	3.7	4.3	8.34

[1] *Mean distance (km) between successive relocations.* [2] *Maximum distance (km) between successive relocations.*

[3] *Length (km) of home range X axis (east-west).* [4] *Length (km) of home range Y axis (north-south).*

[5] *Minimum convex polygon [calculated by McPaal©].*

* *Deer no. 39 was first captured as a fawn 6 Mar'92, then collared as an adult 1 Feb'94.*

Adult female multi-annual MCP home ranges varied from 4.96 km^2 (deer #38; 4 March 1992 to 21 October 1996) to 36.96 km^2 (deer #42; 7 March 1992 to 20 September 1994). The mean multi-annual home range was 14.71 km^2 (n = 21). There was no correlation between home range size and the number of relocations defining the home range ($r^2 = 0.0245$). The lack of a central tendency toward a common home range size suggests that home ranges are highly variable, reflecting individual circumstances and habitat requirements (Figures 4.4.1a-d).

The mean distance between successive relocations among individual deer varied from 0.6 km (#8 and #70) to 4.1 km (#65, male) (Table 4.4.1). The maximum distance between successive relocations among individual deer varied from 1.7 km (#70) to 9.2 km (#16 and #54). As expected, the *x*-axis and *y*-axis dimensions varied with home range size. Linear dimensions of the smallest multi-annual home ranges (i.e., < 10 km^2) were generally 4 km in either direction. Linear dimensions of the largest multi-annual home ranges (i.e., > 20 km^2) were generally 6 km to 10 km in either direction. Maps of individual home range for each radio-collared deer are provided as an Appendix to this report.

4.4.1 Seasonal Range Components

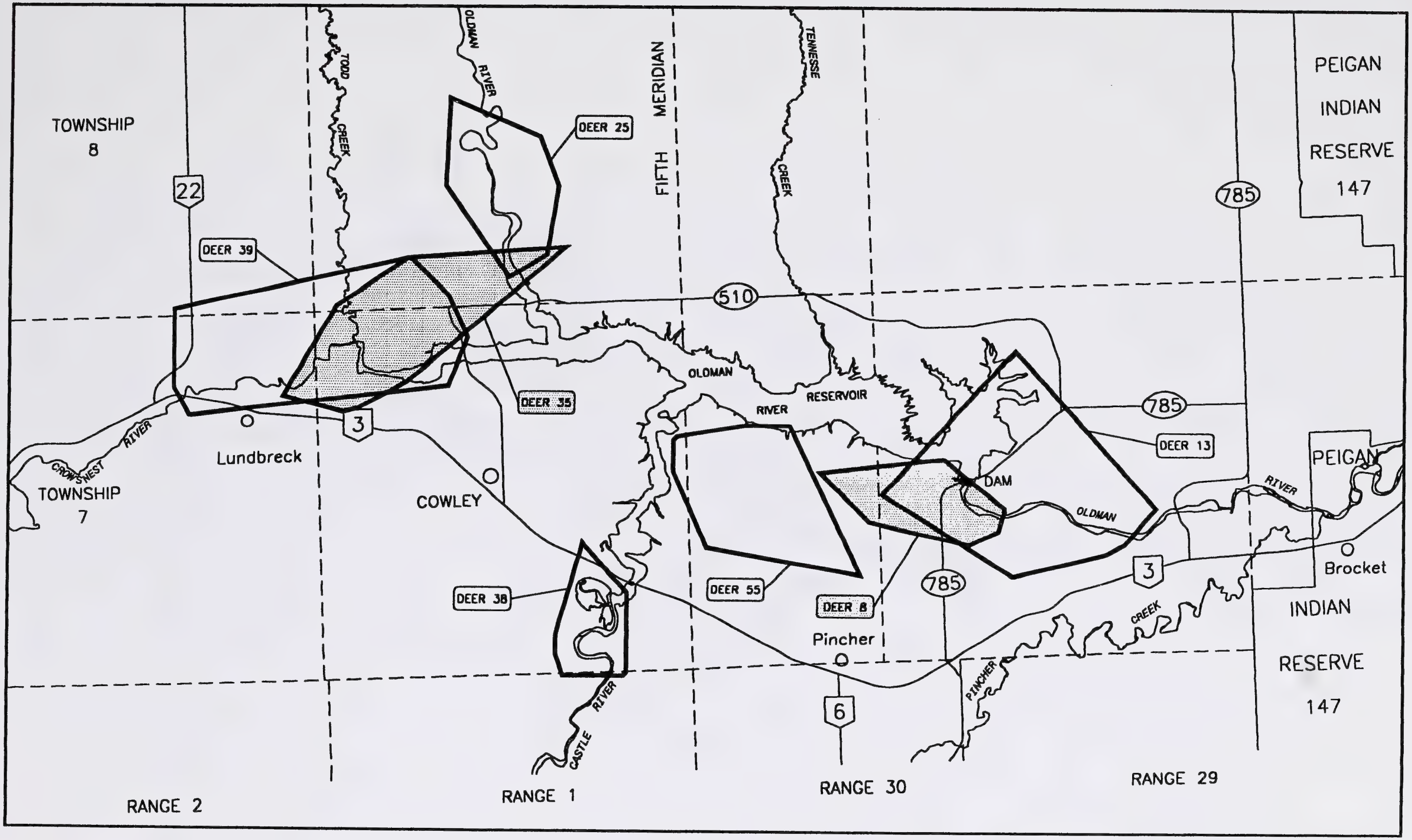
Comparison of winter and reproductive ranges with annual home ranges illustrate changes in movement patterns that occur at these two "critical" times. Winter is a time of bioenergetic stress when food resources are limited and movement activity is reduced. During the reproductive season, movements of female deer are restricted by the limited mobility of the fawn.

Winter Range

Female winter ranges at the Oldman River Dam were consistently smaller than annual home ranges (Table 4.4.2). Multi-annual winter ranges varied from 1.5 km^2 to 17.4 km^2 with a mean of 8.18 km^2 (n = 22). As observed for annual home ranges, the size of winter ranges varied among individuals. Individuals with large annual home ranges tended to have the largest winter ranges ($r^2 = 0.7045$). On average, mule deer winter ranges at the Oldman River Dam tended to comprise about 55% of the annual home range.

Reproductive Range

Multi-annual reproductive ranges were delimited by movements during June and July. On average, reproductive ranges were 3.52 km^2 (Table 4.2.2), although among individuals reproductive ranges varied from < 1 km^2 to > 12 km^2. Compared to winter and annual home ranges, the comparatively small reproductive ranges revealed that adult female mule deer restricted their movements during this time of the year to meet the security and nutritional needs of the fawn. Four radio-collared females displayed comparatively large multi-annual reproductive ranges: deer #13, #16, #39 and #42. Unlike others who showed some degree of annual fidelity to reproductive areas (see section 4.4.3), these deer appeared to select different areas year to year to drop fawns.



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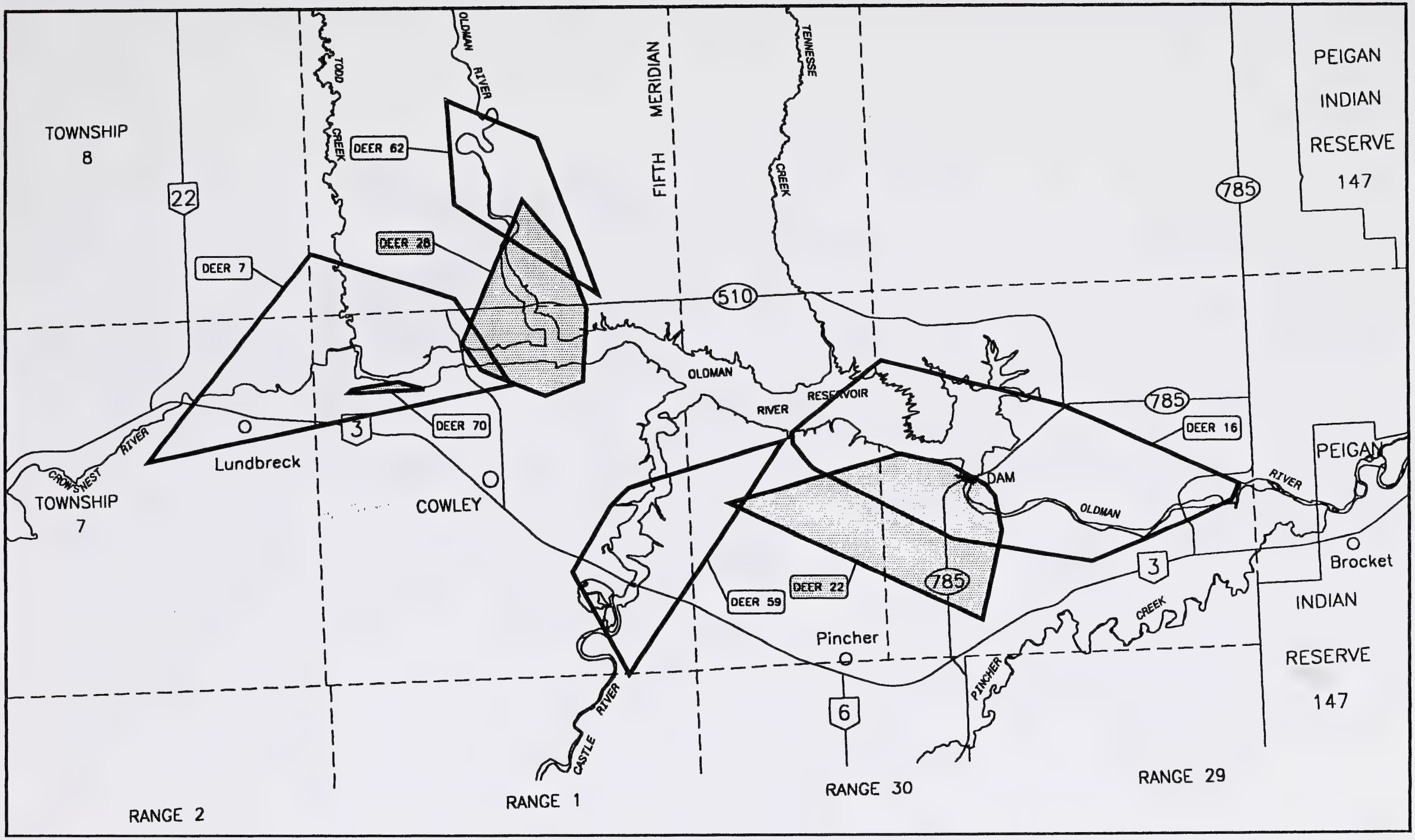
OLDMAN RIVER DAM - MULE DEER MONITORING

MULE DEER MULTI-ANNUAL HOME RANGES

FIGURE No. 4.4.1a



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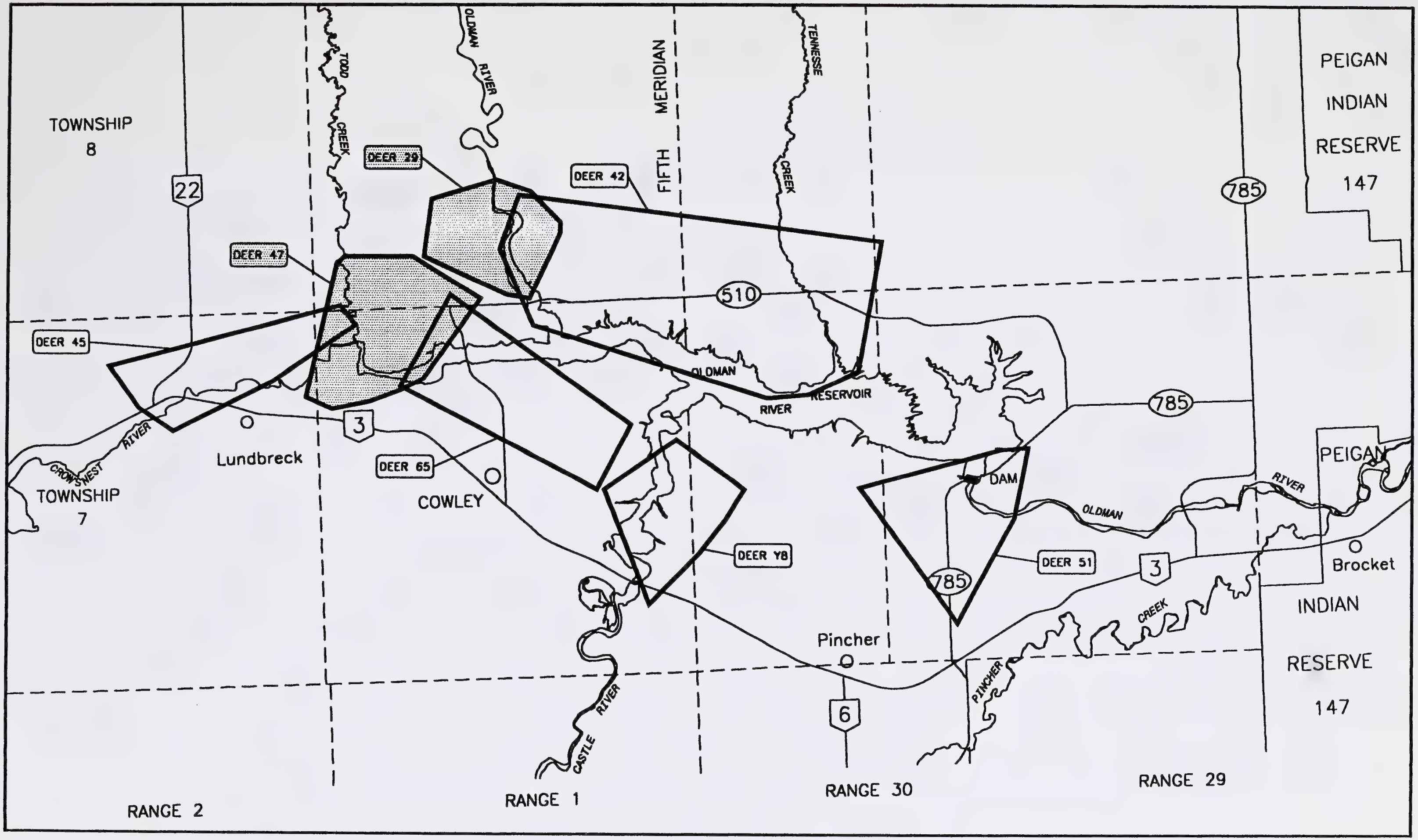
MULE DEER MULTI–ANNUAL HOME RANGES

FIGURE No. 4.4.1b



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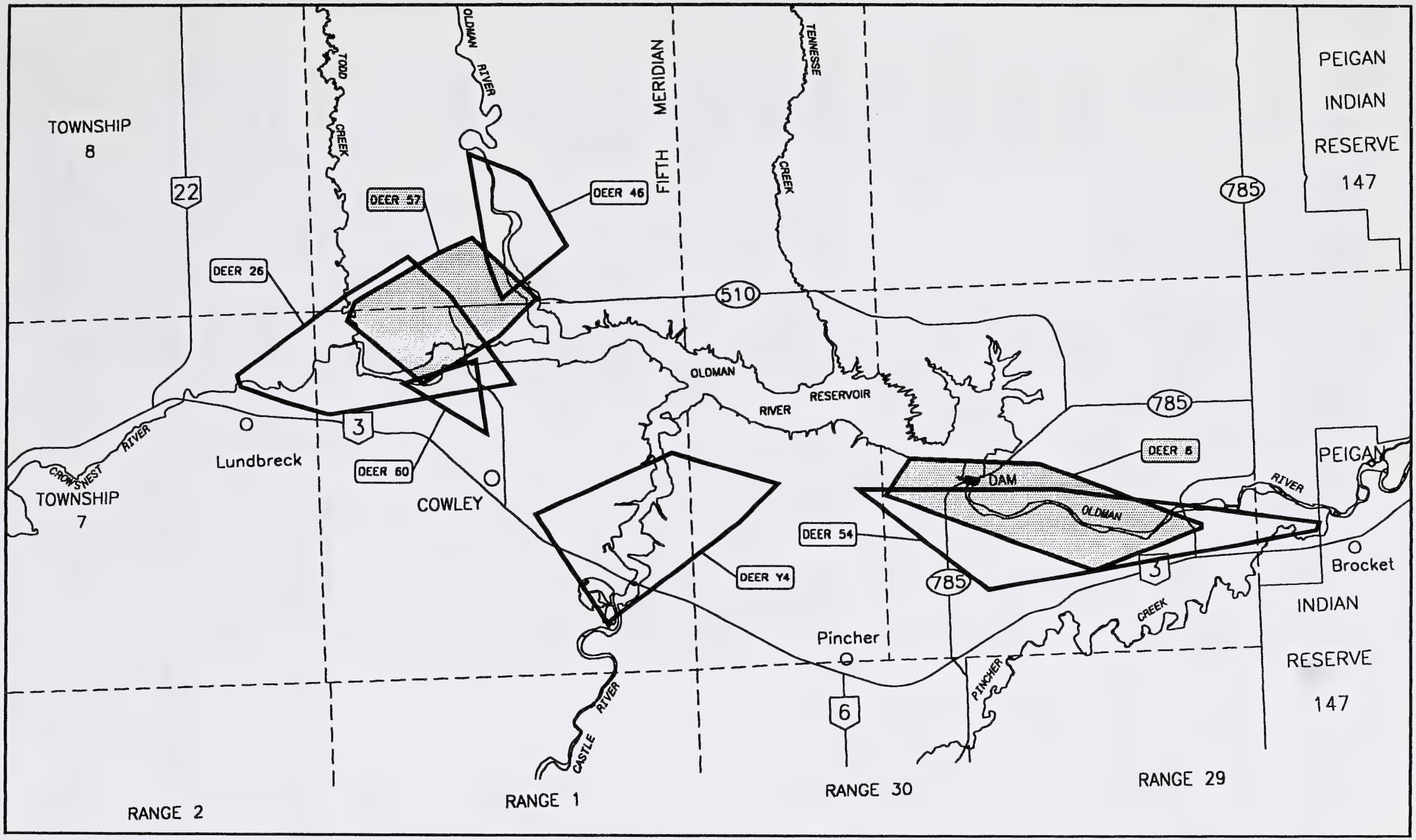
MULE DEER MULTI-ANNUAL HOME RANGES

FIGURE No. 4.4.1c



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OLDMAN RIVER DAM – MULE DEER MONITORING

MULE DEER MULTI-ANNUAL HOME RANGES

FIGURE No. 4.4.1d

Table 4.4.2 Multi-annual seasonal range components (minimum convex polygons, km^2) for Oldman River Dam mule deer. Number in brackets is the no. of relocations available for defining MCP.

Deer No.	Multi-annual Home Range	Multi-annual Winter Range (December to March)	Multi-annual Reproductive Range (June to July)
6F, 1992-94	12.86 (55)	6.92 (19)	1.4 (19)
7F, 1992-94	25.57 (61)	17.31 (24)	1.04 (17)
8F, 1992-96	6.76 (111)	3.36 (43)	0.98 (29)
13F, 1992-95	22.70 (60)	15.5 (24)	8.41 (17)
16F, 1992-96	35.08 (68)	13.51 (27)	12.18 (23)
22F, 1992-95	8.73 (76)	2.98 (31)	2.56 (20)
25F, 1992-96	9.17 (76)	5.17 (36)	2.57 (19)
26F, 1992-95	16.21 (88)	13.05 (33)	2.76 (30)
28F, 1992-94	10.69 (44)	7.58 (14)	2.69 (12)
29F, 1992-95	7.76 (54)	3.45 (24)	3.94 (11)
35F, 1992-95	14.8 (96)	11.07 (34)	2.10 (34)
38F, 1992-96	4.96 (92)	4.18 (36)	1.90 (33)
39F, 1992-96	23.56 (45)	8.01 (23)	11.29 (14)
42F, 1992-94	36.96 (64)	17.44 (19)	9.77 (11)
45F, 1992	9.08 (34)	too few relocations	0.31 (10)
46F, 1992-93	5.24 (53)	2.46 (13)	0.60 (18)
47F, 1992-96	12.18 (110)	8.54 (40)	1.90 (38)
51F, 1994-96	10.26 (56)	5.79 (29)	0.70 (13)
54F, 1994	17.62 (12)	6.90 (10)	too few relocations
55F, 1994	12.52 (11)	too few relocations	too few relocations
57 Male, 1994-95	10.26 (11)	too few relocations	male deer
59F, 1994-96	13.9 (35)	9.80 (11)	1.28 (16)
60F, 1994	1.89 (8)	too few relocations	too few relocations
62F, 1994-96	9.07 (28)	1.55 (13)	6.07 (12)
65 Male, 1994	13.61 (8)	too few relocations	male deer
70F, 1996	0.30 (8)	too few relocations	too few relocations
Y4F, 1995-96	14.12 (31)	6.94 (14)	1.93 (11)
Y8F, 1992-96	8.34 (41)	8.49 (29)	1.08 (9)
Mean	14.71	8.18	3.52

However, in a given reproductive season, the above female deer remained in similarly restricted areas during June and July:

- #13, 1992 – 0.26 km^2 (7), 1993 – 0.12 km^2 (4);
- #16, 1992 – 9.37 km^2 (10), 1995 – 0.44 km^2 (9);
- #39, 1994 – 2.59 km^2 (4), 1995 – 0.58 km^2 (6); and
- #42, 1993 – 0.42 km^2 (5), 1994 – 1.38 km^2 (3).

With few exceptions, parturient females selected habitat in the river valley or habitat closely associated with it (see section 4.5.3).

Mule deer home range size at the Oldman River Dam appear similar to other mule deer movement patterns reported in the literature. Yearlong resident mule deer in a prairie environment in eastern Montana had polygon home ranges that varied from 1.83 km^2 to 13.64 km^2 (Wood *et al.* 1989). Adult females in this population occupied the same home range year to year, showing high fidelity to discrete areas. In another study area of the east front of the Rocky Mountains in Montana, mule deer showed a high degree of fidelity to discrete winter and summer home ranges. Multi-annual (3 years) winter ranges for 10 females averaged 15.9 km^2, while summer home ranges for seven females followed through 3 years averaged 11.1 km^2 (Pac *et al.* 1988). In the foothills of northeastern Colorado, mule deer were also observed as year-round residents in relatively small home ranges (Kufeld *et al.* 1989). In this Colorado population, winter ranges averaged < 2 km^2 during three years of study. These relatively small home ranges in northeastern Colorado were considered a reflection of high quality habitat.

4.4.2 Emigration

During five years of study, no radio-collared females were observed to emigrate from the Oldman River Dam project area. One of the adult female mule deer (deer #6), however, undertook an apparent dispersal after the 1994 reproductive season. Deer #6 then returned to its home range after the 1995 reproductive season, dispersed again and then was killed in the November 1995 hunting season. Deer #6 remained within a home range of 12.8 km^2 from the time it was radio-collared in February 1992 until July 1994 (n = 55 relocations). During this time, deer #6's movements were confined to the immediate downstream reaches of the Oldman Dam. Following the 1994 fawning season, #6 was relocated during January 1995 some 13 km to the southwest in the Pincher Creek drainage west of the Town of Pincher Creek. Deer #6 remained in the Pincher Creek drainage during summer 1995 where she dropped a fawn. Deer #6 was subsequently relocated back at the Dam in early fall 1995 (1 November) and then was killed by a hunter near her 1995 summer range along the Pincher Creek drainage. Deer #6 was the only deer in our study group that was observed to use two different range areas between years.

4.4.3 Fidelity to Reproductive Areas

Fidelity is an expression of the degree of site attachment, or degree of restriction to a particular area. The issue of female fidelity to reproductive ranges was addressed at the Oldman River Dam because fawning is considered a "critical" time of year when female habitat requirements are highly specific and related to the security needs of fawns. An understanding of adult female behavior and habitat requirements during parturition has been considered basic ecological information that can be helpful for management of the land base. The straight-line distance (estimated ± 100 m on 1:50,000 scale topographic maps) based on geometric relationships of easting and northing coordinates between fawn birth locations each year was used to identify female attachment to reproductive areas.

Most adult female mule deer dropped fawns within the same general area of the annual home range during consecutive and alternate years, indicating a degree of localized fidelity (Table 4.4.3). The overall mean distance among 50 consecutive and alternate year comparisons of fawn birth locations among years was 0.81 km (excluding the large year to year fawning locations selected by deer #6 and #42). Fidelity to reproductive ranges was generally not "patch" specific. However, on occasion fidelity to fawning areas in consecutive and alternate years was "patch" specific, demonstrating a high degree of fidelity to reproductive areas. As mentioned earlier, mule deer such as #13, #16, #39 and #42 appeared to change geographic locations during parturition year to year. Differences in fawn locations year to year for deer #13 and #16 are not calculated in Table 4.4.3 because fawns were only observed directly during a single year.

It appears that while the Oldman mule deer are highly adaptable in the choice of reproductive habitat, a tendency was shown to return to localized reproductive ranges each year. Occasional "patch" fidelity indicates that micro-habitat appears to be less important to fawning than larger landscape variables that have yet to be identified.

4.5 Productivity and Mortality

The productivity of the Oldman River Dam mule deer herd was monitored with repeated close approach to radio-collared females during the reproductive season of June and early July, from 1992 to 1996. This was accomplished in most cases without alarming the deer or influencing movements. In this way, a reproductive history over the five years of study was obtained. Information obtained included:

- date of birth;
- birth location; and,
- number of fawns.

Mortality of the Oldman herd was estimated by radio-collar returns, including investigation of mortality signals that were emitted by immobile collars.

Table 4.4.3 Straight-line distance (km) between observed fawn birth locations for individual radio-collared female mule deer among years at the Oldman River Dam project area.

		Distance Between Consecutive Years				Distance Among Alternate Years					
Deer No.	Years fawns were located	1992 to 1993	1993 to 1994	1994 to 1995	1995 to 1996	1992 to 1994	1992 to 1995	1992 to 1996	1993 to 1995	1993 to 1996	1994 to 1996
6	1993 and 1995								14.37		
7	1992, '93, '94	0.72	0.92			1.00					
8	1993, '94, '95, '96		0.32	0.30	0.63				0.20	0.60	0.32
25	1992, '93, '95, '96	0.85			0.10		0.41	0.40	0.71	0.81	
26	1992, '93, '94, '95	1.96	2.52	2.66		0.63	2.00		1.20		
35	1993, '94, '95, '96		0.22	1.00	0.00				0.78	0.78	1.00
38	1992, '93, '94, '95, '96	1.00	0.57	1.28	1.02	1.22	1.02	0.00	0.72	1.00	1.22
39	1994 and 1995			0.81							
42	1993 and 1994		9.39								
47	1993, '94, '95, '96		0.22	1.00	0.91				0.92	0.30	0.14
51	1994 and 1995			0.10							
59	1995 and 1996				0.45						
62	1995 and 1996				0.22						
Y8	1994, '95, '96			1.39	1.55						0.22
Mean by consec. & alternate yrs		1.13	0.80	1.07	0.61	0.95	1.14	0.20	0.76	0.70	0.58

Mean distance between all pairs excluding deer #6 and deer #42 = 0.806 km

4.5.1 Parturition Date

The majority of mule deer fawns at the Oldman River Dam were born near the middle of June (Figure 4.5.1). However, fawns were observed in the study area as early as 31 May, and as late at 7 July. For all intents and purposes, the month of June can be considered the time of birth for mule deer. Timing of fawn births at the Oldman Dam is

consistent with earlier reports from westcentral Alberta by McTaggart-Cowan that mule deer fawns arrive in the second week of June (*in* Taylor 1956). The peak mule deer fawning period in Utah has been estimated at 19-20 June (Robinette *et al.* 1977 *in* Wallmo 1981). In Colorado, the mule deer fawning period has been estimated at 16 June to 6 July (Anderson and Medin 1967 *in* Wallmo 1981).

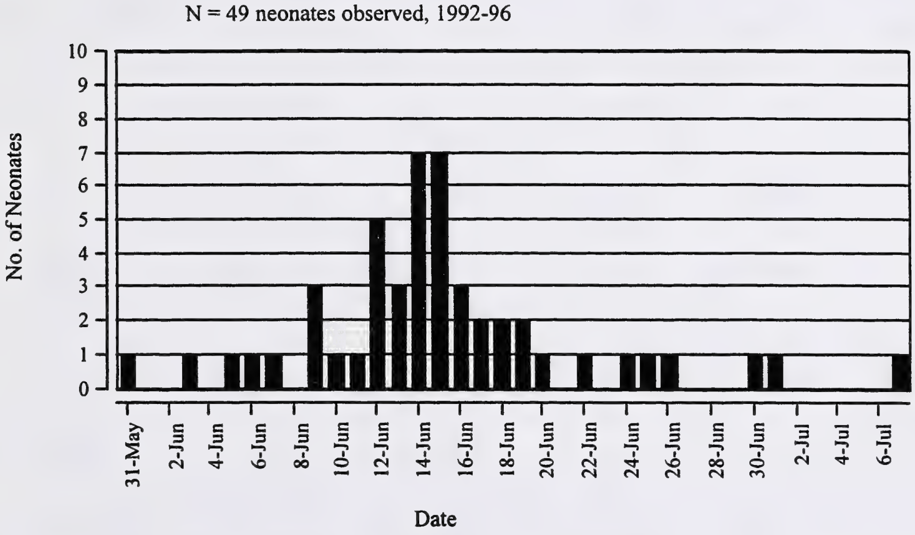

Figure 4.5.1 Dates of fawn birth from 20 radio-collared adult females at the Oldman River Dam project area, southwestern Alberta, 1992 to 1996.

Peak of Rutting Season

Based on peak fawning during mid-June, and a gestation period of 200 to 208 days (Robinette *et al.* 1973, Anderson 1981 and Anderson and Wallmo 1984), the peak mule deer rut in the Oldman River Dam project area of southwestern Alberta occurs during mid to late November (19 to 27 November). This breeding peak appears to be slightly earlier than reported for mule deer at more southern latitudes such as Colorado, but similar in timing to adjacent Montana (Anderson 1981).

4.5.2 Productivity

The birth of single fawns were common in the Oldman River Dam project area, representing 71% of fawn births. Twin births (plus 2 triplets) were observed on occasion, but overall twins (including triplets) were about 28% of all fawn births (Table 4.5.1). Generally in mule deer, singletons are considered less common than twins, particularly among females in their third breeding season (Anderson and Wallmo 1984).

Table 4.5.1 Mule deer parturition dates during five consecutive reproductive seasons at the Oldman River Dam, 1992 to 1996. Includes only females confirmed with fawns in the fawning season.[1] Twins and triplets are indicated beside the date of birth; all other dates indicate single fawns.

	Reproductive Season					Variation among years (days)
Deer No.	1992	1993	1994	1995	1996	
6		15 June		25 June		10
7	9 June	12 June	22 June			13
8		15 June	9 June	15 June-2	14 June-2	6
13	incomp. loc.	14 June	incomp. loc.	Dead		
16	incomp. loc.	incomp. loc.	incomp. loc.	20 June	not relocated	
22	incomp. loc.	incomp. loc.	14 June	Dead		
25	6 June	7 June	incomp. loc.	14 June-2	17 June-2	11
26	11 June	16 June	16 June	19 June-2	Dead	8
28 -	incomp. loc.	5 June	Dead			
35	incomp. loc.	14 June	12 June	26 June	10 June-3	16
38	12 June-2	12 June-2	1 July	19 June	18 June	19
39	not relocated	not relocated	15 June	13 June-2		2
42	incomp. loc.	15 June	7 July	Dead		22
46	incomp. loc.	13 June	Dead			
47	incomp. loc.	17 June	30 May-3	13 June-2	16 June	17
51			14 June-2	15 June	not relocated	1
59				15 June	14 June	1
62				24 June	18 June	6
Y8			9 June-2	31 May-2	3 June	9
70					12 June	
Mean Date by year	9 June (n=4)	12 June (n=12)	19 June (n=11)	16 June (n=13)	13 June (n=9)	
Fawns/female	1.25	1.08	1.36	1.46	1.44	

[1] *#29 accompanied by fawn on 14 July 1994.*
#45 - did not find a fawn in 1992, but low intensity search was conducted.
#55 - no fawn was observed in 1994, but low intensity search was conducted.
#60 - no fawn observed in 1994, but low intensity search was conducted
#Y4 was never observed with a fawn in 1995 with intensive search, or in 1996 with low intensity search.

Triple fawn births were relatively rare in the Oldman mule deer population, about 4% of all fawn births observed. Anderson and Wallmo (1984) reported that triplets are generally about 1.4 % of mule deer births.

Productivity of the Oldman mule deer herd averaged 1.33 fawns per year per adult female. The data revealed an overall increase in productivity during the study; 1993 was a year of relatively low productivity with 1.08 fawns/ female, whereas 1995 showed the highest productivity among years with 1.46 fawns/ female (Table 4.5.2). The corresponding twinning rate during years of low and high reproduction was 8% and 46%, respectively. A 60% twinning rate has been reported for mule deer in other areas. Triplets are known to be relatively rare among mule deer (Anderson and Wallmo 1984, Mackie *et al.* 1982) as observed in the Oldman River Dam project area.

Table 4.5.2 Reproductive parameters of radio-collared mule deer during five consecutive fawning seasons at the Oldman River Dam project area, 1992 to 1996. *Percent twins = no. of twins ÷ no. females with fawns.*

Fawning Season	No. Females Observed w/ Fawns	Total No. Fawns Born (twins/triples)	Female Productivity (Fawns/ Female)	Twinning Rate (Percent Twins)
1992	4	5 (1)	1.25	25% (1/4)
1993	12	13 (1)	1.08	8% (1/12)
1994	11	15 (3)	1.36	27% (3/11)
1995	13	19 (6)	1.46	46% (6/13)
1996	9	13 (3)	1.44	33% (3/9)
Total/ Mean	49	65 (14)	1.33	28% (14/49)

Not all radio-collared females were observed each year with a fawn. This occurred when the intensity of relocation efforts during the reproductive season was relatively poor. Therefore, lack of fawn(s) observed in a particular year was not considered evidence of non-pregnancy, rather the results were recorded as "incomplete" (Table 4.5.1). Throughout the study only one female was approached intensively throughout the fawning season without any evidence of a fawn (#Y4 in 1995). This was the only case of suspected non-pregnancy that was observed. It is concluded, therefore, that the pregnancy rate of adult females in the Oldman River Dam project area has been high, in the region of 98%.

The highest productivity known for mule deer is about 1.90 fawns/ female (Robinette *et al.* 1973). The reported range of productivity for mule deer is 1.4 to 1.8 fawns/ female (Mackie *et al.* 1982). In a prairie environment of eastern Montana, mule deer productivity averaged 1.50, 1.43, 1.29, 1.27 and 1.54 fawns/ female during July 1982 to 1986, respectively (Wood *et al.* 1989). The authors of this Montana study considered that productivity in the herd was relatively high. These Montana values are similar to what has been observed at the Oldman River Dam. Yearling productivity is generally observed to be lower than in adults, and in the range of 0.78 to 1.33 (Sadleir 1987) and 1.206 to 1.269 (Connolly 1981). Using these comparisons, the results from the current study indicate that the Oldman Dam mule deer have remained productive in the immediate years following Reservoir development.

Recruitment of Fawns

Annual mortality/ survival of fawns can be estimated from a comparison of mid-winter composition counts obtained during aerial surveys to fawn:female ratios the preceding reproductive season (see Table 4.2.3 and Table 4.5.2). Fawn mortality at the Oldman River Dam project area was 60% following the 1992 reproductive season (i.e., 125 fawns:100 females produced spring 1992, and subsequently reduced to 50 fawns:100 females during mid-winter 1992-93, indicative of relatively low survival). Fawn mortality was 46% following the 1993 reproductive season (i.e., 108 fawns:100 females produced during spring 1993, and subsequently reduced to 58 fawns: 100 females during mid-winter 1993-94, indicative of improved survival). While there could be additional mortality in late winter, these two years of data suggests that mortality of mule deer in the first year of life can be expected to be ≤ about 60%.

4.5.3 Reproductive Habitat

During the reproductive season (defined as June and July), most female mule deer were closely associated with the river valley and adjacent benchlands and coulees. Maternal deer were observed in all eight (8) habitat types within the Oldman River Dam project area (Figure 4.5.3). Five habitat types were most common at birth locations, accounting for 79% of all observations. In decreasing frequency of occurrence, the five most frequented habitat types used by parturient females were: coulee shrubland, upland grasslands, riverine cottonwood, Douglas fir and coulee grasslands. A brief description of these habitat types follows.

Coulee shrublands are comprised of chokecherry and saskatoon and occur within most of the coulee formations associated with river breaks that lead into the Reservoir. These shrublands occupy the lee slopes of coulee formations where moisture and soil conditions are most favorable. Upland grasslands are native grasslands surrounding the Reservoir topographically above the coulee formations of the river breaks. Upland grasslands are dominated by wheat grass (*Agropyron smithii*) - June grass with some rough fescue and oat grass. Stands of cottonwood (*Populus* spp.) occur in areas of the reservoir above the full supply level and within some of the deeper coulee formations

where ground water is at or near the surface. Douglas fir stands remain on steep slopes in a number of areas surrounding the Reservoir and extending down to the full supply line. Coulee grasslands are native grasslands associated with coulee formations. These grasslands occur mostly on windward slopes of coulee formations, which have dry aspects. Generally, rough fescue (*Festuca scabrella*) is the dominant grass. Aspen habitat is comprised of aspen clones associated with river banks, generally in upper reaches of the Reservoir. Upland shrub communities are comprised of chokecherry and saskatoon that occur on gentle slopes associated with the agricultural landscape above the coulee formations of the river breaks. Cultivated fields surround the Reservoir and are cultivated for cereal grain and alfalfa. Hay crops such as barley and wheat are the principle grains, and beef cattle are the dominant livestock (Alberta Agriculture 1991).

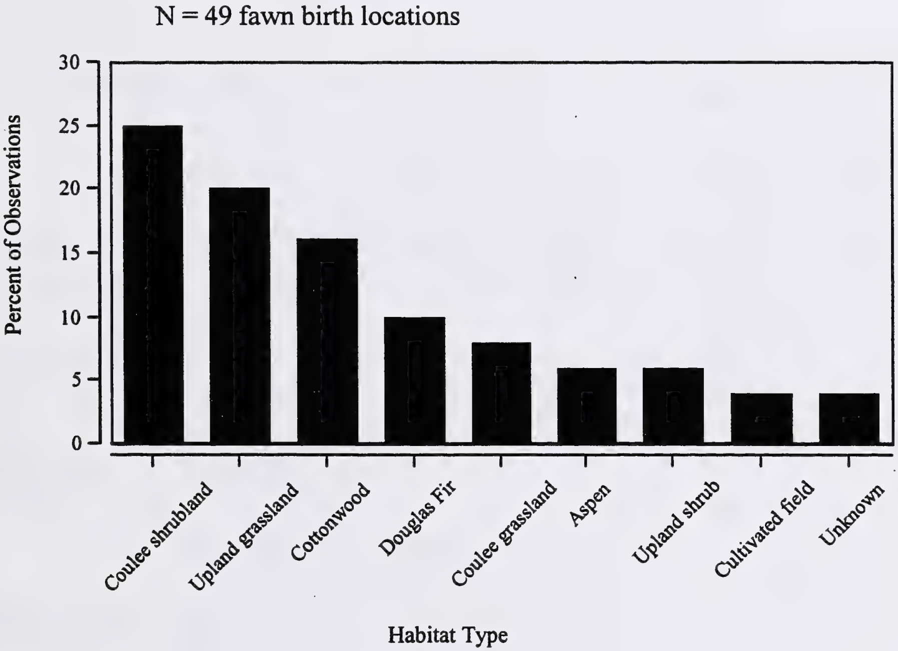

Figure 4.5.3 Habitat types used by adult female mule deer observed with neonate fawns in the Oldman River Dam project area, 1992-1996.

These results suggest that female mule deer at the Oldman River Dam are not highly selective for a given habitat type during parturition. However, while dense hiding cover for the fawn does not appear to be a universal requirement, most fawns were born in areas of tree and shrub cover, presumably for concealment. In areas without dense cover, the fawns are concealed by cryptic coloration, and particularly young fawns tend to

remain motionless when approached which adds to concealment from natural predators (Geist 1981).

4.5.4 Adult Female Mortality

Percent annual adult female mortality, based on death of radio-collared animals for the period 1992 to 1996, was estimated to be 18% (based on the methods of Gasaway *et al.* 1983). Known sources of mortality to adult females deer at the Oldman River Dam included (Table 4.5.4):

- legal harvest during the fall hunting season (n = 6);
- vehicle collisions on roads (n = 2); and
- accidents (n = 1).

Table 4.5.4 Patterns of mortality to radio-collared female mule deer at the Oldman River Dam. (Cause of mortality: Ukn = unknown cause [7]; Harvest [6]; Acc. = accidental [1]; Road killed [2]).

	Capture Year (1992)	1st Year (1993)	2nd Year (1994)	3rd Year (1995)	4th Year (1996)
1992 Capture Cohort (16 radio-collared)		#46-Harvest	#7-Ukn #28-Ukn #42-Acc	#6-Harvest #13-Ukn #22-Ukn #26-Ukn #29-Ukn	#39-Road
	Capture Year (1993)	1st Year (1994)	2nd Year (1995)	3rd Year (1996)	
1993 Capture Cohort (3 radio-collared)	#Y6-Road				
	Capture Year (1994)	1st Year (1995)	2nd Year (1996)		
1994 Capture Cohort (9 radio-collared)	#54-Harvest #55- Harvest #60- Harvest #65- Harvest				
	Capture Year (1996)				
1996 Capture Cohort (3 radio-collared)	#Y15-Ukn				

The accidental mortality occurred when #42 caught a front leg under the collar (2.5 years after radio-collared). Circumstances suggest this handicap lead to coyote predation, or the deer was shot by a local landowner as euthanasia. In addition, there were seven (7) deaths of unknown cause to radio-collared females. Cause of death to these deer was not determined because the investigator arrived late at the carcass (Table 4.5.4).

4.6 Food Habits

The description of mule deer food habits at the Oldman River Dam has been limited to one fecal collection period during one winter season (see Methods). This limited sample means that caution is required for the following generalizations and interpretations. To this extent then, the mule deer diet appeared to be different in each region of the Oldman study area, perhaps reflecting local forage availability (Table 4.6). Collectively, shrubs were the dominant forage class in the winter diet, comprising 75.8% of foods selected. Grasses and forbs shared 13.5% and 10.7%, respectively of the overall winter diet.

This description of mule deer forage class selection at the Oldman River Dam is concurrent with mule deer's niche as a small browser of dicot plants (compared to a grazer of monocot plants) (Hudson 1985). Mule deer are selective, intermediate feeders, adapted to a wide range of food items, choosing among the most digestible and non-toxic portions of plants (Wallmo 1978, Geist 1990). Furthermore, the winter foraging pattern of mule deer at the Oldman River Dam appears to be similar to that previously described for mule deer in winter within the Montane ecoregion of Jasper National Park and the Aspen Parkland ecoregion of Wainwright (Table 12.5 – Seasonal Foraging Patterns, *in* Renecker and Hudson 1993). In the above mentioned ecoregions of Alberta, grasses and forbs comprised about 11% and 15% of the mule deer's winter diet, respectively, while trees and shrubs comprised about 75% of the diet.

Juniper (*Juniperus* spp.) tended to dominate the diet in four of the five sampled areas around the Oldman River Dam, although its proportion in the diet varied. In addition to juniper, a variety of other woody species were important in the diet; namely saskatoon (*Amelanchier alnifolia*), bearberry (*Arctostaphylos uva-ursi*), and buffaloberry (*Shepherdia*)/wolf willow (*Elaeagnus*). Wheat grass (*Agropyron* spp.) was not an important dietary item, however, fescue (*Festuca* spp.) occurred in all diet samples and moderately so in two of these. Two forbs appeared to be important to the Oldman mule deer diet: vetch (*Astragalus* spp. - *Oxytropis* spp.) and alfalfa (*Medicago* spp.).

Selection of individual plant species as food items by mule deer at the Oldman River Dam contains few differences from the published literature. For example, fescue and wheat grass have both been identified as common forages for mule deer (Table 12.6 – Common Forages, *in* Renecker and Hudson 1993). The same is true for most forbs and shrubs identified in the Oldman mule deer diet. Mistletoe and toad flax occurred in trace amounts in the diet at the Oldman Dam, and neither have been reported as common

forages. Similarly, skunkbrush and honeysuckle were both found in relatively small amounts in the Oldman mule deer diet, and neither have previously been identified as common forages for mule deer in Alberta. Skunkbrush occurs in mule deer food habits in the western States (Wallmo and Regelin 1981). All of the other shrub species in the Oldman mule deer diet are known mule deer food items.

Table 4.6 Mean percent relative density (± SD) of discerned plant fragments from mule deer fecal samples at the Oldman River Dam project area, southwestern Alberta. (Collection dates in brackets)

	Location and Date Pellet Groups Collected				
Botanical Species by Forage Class	Castle River (3 Feb'92)	Crowsnest River (3 Feb'92)	Glass Property near Dam (4 Feb '92)	North Fork Oldman R. (4 Feb'92)	Main Stem Oldman R. (13 Feb'92)
Grasses					
Agropyron (wheat grass)	1.3 (1.8)		2.4 (1.4)		
Festuca (fescue)	14.9 (3.5)	4.6 (3.3)	31.5 (4.5)	9.0 (1.8)	3.7 (1.5)
Percent of Composite sample = 13.49%					
Forbs					
Arceuthobium (mistletoe)	0.7 (1.5)				
Astragalus (vetch)-*Oxytropis* (locoweed)		0.5 (1.1)	1.7 (2.6)	0.3 (0.6)	
Comandra (toad flax)	0.6 (1.3)				
Lupinus (lupine)	2.5 (2.7)			1.3 (1.9)	
Medicago (alfalfa)	4.8 (4.1)	15.5 (2.9)	11.9 (2.6)	2.5 (1.5)	8.0 (2.3)
Composite	0.6 (1.4)		1.8 (1.7)	0.4 (0.8)	0.4 (0.9)
Percent of composite sample = 10.70%					
Shrubs					
Juniperus (juniper)	32.1 (4.8)	58.1 (4.8)	30.7 (6.2)	78.1 (4.3)	9.6 (2.6)
Amelanchier (saskatoon)	7.3 (1.3)		9.8 (4.5)	1.5 (1.7)	52.6 (5.8)
Arctostaphylos (bearberry)	0.6 (1.3)	15.6 (3.6)	1.2 (1.6)	0.7 (1.6)	3.1 (1.6)
Shepherdia (buffaloberry)-*Elaeagnus* (wolf willow)	22.6 (5.6)	4.8 (1.7)		1.1 (0.9)	13.2 (3.1)
Pseudostuga (Douglas fir)	4.7 (3.8)	0.9 (2.1)		4.9 (2.1)	1.4 (1.3)
Potentilla (cinquefoil)	1.2 (2.7)				
Rhus (skunkbrush)	6.1 (3.4)		3.2 (2.3)	0.3 (0.6)	4.8 (3.4)
Salix (willow)			3.2 (2.5)		
Spirea (honeysuckle)					3.1 (1.2)
Seed			2.4 (2.6)		
Percent of composite sample = 75.81%					

The high percentage of juniper in the mule deer diet at the Oldman Dam is noteworthy. Juniper is known to be of questionable nutritional value to ruminants, and in

large amounts (i.e.,> 20 % of diet) it is known to inhibit bacterial activity in the rumen (Wallmo and Regelin 1981). The same is true for Douglas Fir. Food items such as juniper, sagebrush and Douglas fir are often considered “emergency” winter food items. Perhaps the Oldman River Dam ecotypes of these species are more palatable and tolerable than others that have been studied. More likely, it’s a reflection of sample size.

4.7 Population Dynamics

Different kinds of information regarding the status of the Oldman River Dam mule deer have emerged from field studies conducted in the immediate post-development years of reservoir operation, 1990 to 1996. Information regarding the population dynamics of mule deer revealed that:

- the population has increased at about 11% annually based on counts from mid-winter aerial surveys;
- the recruitment of fawns has been variable, from 40% to 54% based on fawn:female ratios at mid-winter;
- the reproductive rate has been relatively high, averaging 1.33 fawns per adult female per year based on observed fawn births; and,
- annual adult female mortality has been relatively low, at about 18 percent based on mortality of radio-collared females.

On balance, female reproduction appears to have exceeded female annual mortality, which supports the observed increasing population trend in the post-development years of reservoir construction.

To further investigate the population dynamics, a population model was developed as a framework for linking observed reproductive and mortality rates. The model incorporated four age classes for both males and females: fawns, yearlings, 2.5 year olds, and adults. The model allows combinations of observed and assumed population parameters to be experimentally manipulated while observing their effects on population change. The purpose of the modeling exercise was to investigate if the observed population parameters could produce the observed population growth. The model was also used to identify the effects of changing various mortality and reproductive parameters on population growth.

Based on current studies, the observed population parameters in the model were:

- average adult female productivity of 1.326;
- average annual adult female mortality of 0.18; and,
- average fawn mortality about 0.50.

For modelling purposes, the following assumptions were made about other mule deer population parameters at the Oldman River Dam:

- female yearling productivity of 0.85,
- female yearling mortality of 0.30, and,
- yearling and adult male mortality of 0.80.

Using the empirical data and assumptions, the population model predicts a sustained annual population growth of 4.51% (Appendix Table 7.6). The model output is comparable to the observed population change estimated from aerial census.

By experimentally manipulating age-specific mortality rates, recognizing that mortality linkages can be directly influenced by management activities whereas reproductive linkages can not, the model predicts the following population performance:

- increasing adult female mortality 20% from 18% to 21.6% (for example by increasing harvest), without changing other parameters, leads to a population growth rate of +2.28% change each year;

- increasing mortality on fawns 20% from 50% to 60% (for example by additional predators in the system), without changing other parameters, results in a stable population at +0.19% change per year; and,

- increasing mortality 20% on both adult females and fawns (cumulative effects of increased harvest and predation) without changing other parameters results in a decreasing population of about –2.23% per year.

Furthermore, a decrease in adult female productivity from 1.326 fawns/female to 1.00 fawns/female without changing mortality parameters from observed, would result in a stable population of about +0.77% change each year.

Using the observed field data, the population model (to the extent that it simulates the actual population dynamics of the Oldman mule deer) supports the results of the aerial surveys that suggests the herd has been increasing since construction of the Oldman River Dam.

5.0 SUMMARY AND CONCLUSION

The Oldman Reservoir was built during the late 1980's and became operational in June 1992. Landscape changes accompanying reservoir development resulted in removal of some 2,049 ha of river valley habitat. Habitats lost were 313 ha of cottonwood forest, 52 ha of Douglas fir forest, 73 ha of aspen and shrubland habitats, 1259 ha of native grassland and 347 ha of cultivated land. The areal impact of reservoir development was removal to full supply level of approximately 39% of the pre-flooding land base.

The mule deer population in the river valleys of the planned reservoir was not well understood at the time of dam construction. However, four winter aerial surveys were subsequently conducted, and a radio-collaring program targeting adult females was initiated during February and March 1992. These field studies continued through 1996. The ecological and biological data that was assembled on the Oldman River Dam mule deer included:

- complete counts from four winter aerial surveys (1989-90 to 1993-94), corrected and expanded to population estimates based on sightability of radio-collared deer;
- estimates of fawn recruitment from mid-winter aerial survey classification counts (January 1991, February 1993 and February-March 1994);
- seasonal and annual movement patterns, and fidelity to home ranges and fawning areas;
- estimates of adult female productivity based on number of fawns born;
- estimate of adult female percent annual mortality based on collar returns; and,
- a one-time collection of fecal pellets to investigate food habits.

The most recent Oldman mule deer population estimate (February-March 1994) indicates the population may have been as large as 1,208 deer (upper limit of 95% confidence interval). Compared to corrected population counts from earlier winter surveys (1990 and 1991), the mule deer population had increased by about 11% annually. Estimates of adult female productivity in the post-reservoir development landscape averaged 1.326 fawns (with annual variation from 1.083 to 1.461), accompanied by about 18% annual adult female mortality. In addition, mid-winter classification counts revealed relatively high recruitment of fawns with annual variation from 40:100 females in 1991 to 58:100 females in 1994.

These reproductive and mortality parameters were incorporated into a population model that was developed to investigate the population dynamics of the herd. Given the

observed reproductive and mortality parameters, the model predicts an increasing population and supports the observed increase from aerial surveys.

Movement patterns of adult females revealed that the Oldman mule deer were non-migratory, with relatively small multi-annual home ranges. Multi-annual home ranges of adult females averaged 14.71 km^2. There was no central tendency toward a particular home range size, which emphasizes the individual characteristics and requirements of deer. Among 28 radio-collared females providing more than a year of relocations, only one female dispersed temporarily from the three rivers basin into Pincher Creek (in year four, 1995). This deer was killed shortly after in the fall hunting season.

On an annual basis, female mule deer reduced their movement activity to localized habitats during the reproductive season. The peak of fawn births occurred in the middle of June. Most of the adult females returned annually to the same area of their home range to drop their fawns. With few exceptions, parturient females selected fawning habitats in the vicinity of the river valleys. Important habitats included coulee shrublands, native grassland in the upper benchlands of the river valley, and riverine cottonwood stands.

The overall impression that emerges from analysis of these data is that the Oldman mule deer population that inhabited the three river valleys of the planned reservoir has remained large and viable since reservoir development and operation. Prospects for the Oldman mule deer population appear to be favorable, however, continued monitoring is recommended.

5.1 Management Recommendations

Recommendations are built on earlier commitments to continue monitoring the mule deer population at regular intervals over the long-term. The earlier commitments, however, did not provide rules to determine when the monitoring would no longer be relevant and should be stopped. The following is an attempt to answer the question: "when should the monitoring be considered complete?"

Based on earlier evaluations, it is recommended that efforts be maintained to monitor herd productivity with annual maximum composition counts and biannual aerial counts to at least the end of the decade. The end of the decade marks 8 years of periodic monitoring, the estimated maximum life span of a deer (1992-2000). This time frame also represents approximately four generations of mule deer born since the Dam project was completed. A generation time stopping rule is suggested over a review-type rule because lag time can influence environmental effects involving long-lived mammals.

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7.0 APPENDICES

Appendix Table 7.1. List of recent Progress Reports dealing with mule deer field studies initiated at the Oldman River Dam, southwestern Alberta.

Winter Aerial Helicopter Surveys

Hornbeck, G.E. and P. Balagus. 1992. Aerial surveys of the Oldman Reservoir, southwestern Alberta, 1990 and 1991. Prepared for the Oldman Dam Project Office, Alberta Public Works, Supplies and Services, Edmonton, Alberta. Prepared by the Delta Environmental Management Group Ltdl, Calgary, Alberta. 37pp.

Hornbeck, G.E. and P. Balagus. 1993. Aerial Survey of the Oldman Reservoir, southwestern Alberta, 1 to 3 February 1993. Prepared for Alberta Public Works, Supply and Services, Edmonton. Prepared by the Delta Environmental Management Group, Calgary. 36pp.

Hornbeck, G.E. 1994. Aerial survey of the Oldman Reservoir, southwestern Alberta, 28 February to 1 March. Prepared for Alberta Environmental Protection, Development and Operations Branch, Water Management Headworks Branch. Prepared by Axys Environmental Consulting Ltd. 29pp.

Live Capture and Radio-collaring

Hornbeck, G.E. and P. Balagus. 1992. Oldman Reservoir Mule Deer Studies - Progress Report on capture and radio-collaring winter 1991-92. Prepared for Alberta Public Works, Supply and Services, Edmonton. Prepared by the Delta Environmental Management Group Ltd., Calgary. 15pp. + appendices.

Hornbeck, G.E. 1994. Oldman Reservoir Mule Deer Studies - Capture and Radio-collaring winter 1993-94. Prepared for Alberta Environmental Protection, Development and Operations Division, Water Management Headworks Branch. Prepared by Axys Environmental Consulting Ltd., Calgary. 21pp.

Fawn Season - Habitat Use and Productivity

Hornbeck, G.E. and P. Balagus. 1992. Oldman Reservoir Mule Deer Studies - Progress Report on fawn studies 1 - 12 June. Prepared for Alberta Public Works, Supply and Services, Edmonton. Prepared by the Delta Environmental Management Group, Calgary. 29pp.

Hornbeck, G.E., P. Balagus, and R. Lauzon. 1993. Oldman Reservoir Mule Deer Studies - Progress Report on fawn studies 4 - 18 June. Prepared for Alberta Environmental Protection, Fish and Wildlife Services, Lethbridge. Prepared by The Delta Environmental Management Group, Calgary. 26pp.

Hornbeck, G.E. 1995. Oldman Reservoir Mule Deer - Report on fawn studies, 1992 to 1995. Prepared for Alberta Environmental Protection, Development and Operations Division, Water Management Headworks Branch. Prepared by Axys Environmental Consulting ltd., Calgary. 43pp.

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Hornbeck, G.E., P.Balagus, and G.M. Goulet. 1993. Mule deer browse and pellet group surveys of the Oldman Reservoir, 1990-91. Progress Report. Prepared for the Oldman Dam Project Office, Alberta Public Works, Supplies and Services, Edmonton, Alberta. Prepared by the Delta Environmental Management Group Ltd., Calgary, Alberta. 49pp.

Hornbeck, G.E. 1994. Mule deer research at the Oldman Dam. Prepared for and presented at the Alberta Chapter of The Wildlife Society's Annual Conference in Edmonton, Alberta 19-20 March 1994.

Appendix Table 7.2 List of captured mule deer (Odocoileus hemionus) at the Oldman River Dam, 1992 to 1996.

Consec. capture no.	Capture No.	Capture Date	Trap Site	East	North	Map	Sex	Age Class	General Body Cond.	No. of Ticks on Body	Ear Tag i.d.	Radio Collar Freq. (MHz)
1	1.1	5-Feb-92	Glass East	92.3	94.5	82H/12	Female	Yearling	Good	-----	1-183	
1	1.2	20-Feb-92	Downstream	92.3	93.4	82H/12	Recapture				1-183	
1	1.3	28-Feb-92	Glass East	92.3	94.5	82H/12	Recapture				1-183	
1	1.4	27-Feb-92	Glass West	92.3	94.5	82H/12	Recapture				1-183	
2	2.1	5-Feb-92	Glass West	92.3	94.5	82H/12	Female	Fawn	Good	10	2-184	
2	2.2	6-Feb-92	Glass East	92.3	94.5	82H/12	Recapture				2-184	
2	2.3	20-Feb-92	Glass East	92.3	94.5	82H/12	Recapture				2-184	
2	2.4	27-Feb-92	Glass East	92.3	94.5	82H/12	Recapture				2-184	
2	2.5	7-Mar-92	Glass East	92.3	94.5	82H/12	Recapture				2-184	
3	3.1	5-Feb-92	Glass West	92.3	94.5	82H/12	Female	Fawn	Good	5	3-185	
3	3.2	14-Feb-92	Glass West	92.3	94.5	82H/12	Recapture				3-185	
3	3.3	20-Feb-92	Glass East	92.3	94.5	82H/12	Recapture				3-185	
3	3.4	27-Feb-92	Glass East	92.3	94.5	82H/12	Recapture				3-185	
3	3.5	7-Mar-92	Glass East	92.3	94.5	82H/12	Recapture				3-185	
3	3.6	11-Mar-92	Glass West	92.3	94.5	82H/12	Recapture				3-185	
4	4.1	6-Feb-92	Renner North	8.0	98.8	82G/9	Female	Yearling	Good	----	4-186	
4	4.2	21-Feb-92	Renner North	8.0	98.8	82G/9	Recapture				4-186	
4	4.3	6-Mar-92	Renner North	8.0	98.8	82G/9	Recapture				4-186	
5	5.1	6-Feb-92	Brockwell S.	12.3	101.6	82G/9	Female	Fawn	Good	----	5 -187	
5	5.2	12-Feb-92	Brockwell S.	12.3	101.6	82G/9	Recapture				5-187	
5	5.3	28-Feb-92	Brockwell S.	12.3	101.6	82G/9	Recapture				5-187	
6	6	6-Feb-92	Glass West	92.3	94.5	82H/12	Female	Young ad.	Good	----	6-188	148.731
7	7	10-Feb-92	Renner North	8.0	98.8	82G/9	Female	Prime ad.	Good	----	7-189	149.921
8	8.1	11-Feb-92	Spillway	90.2	93.9	82H/12	Female	Young ad.	Good	----	8-139	149.951
8	8.2	28-Feb-92	Spillway	90.2	93.9	82H/12	Recapture				8-139	
9	9	12-Feb-92	Downstream	92.3	93.4	82H/12	Male	Yearling	Good	----	9-140	
10	10	12-Feb-92	Island View	109.0	98.4	82G/9	Female	Fawn	Good	----	10-141	
11	11	12-Feb-92	Brockwell S.	12.3	101.6	82G/9	Male	Fawn	Good	----	11-142	
12	12	13-Feb-92	Glass East	92.3	94.5	82H/12	Female	Fawn	Good	----	12-143	
13	13	13-Feb-92	Glass West	92.3	94.5	82H/12	Female	Senior Ad.	Good	----	13-144	150.095
14	14.1	14-Feb-92	Spillway	90.2	93.9	82H/12	Female	Fawn	Good	----	14-145	
14	14.2	28-Feb-92	Spillway	90.2	93.9	82H/12	Recapture				14-145	
15	15	14-Feb-92	Spillway	90.2	93.9	82H/12	Male	Fawn	Poor	----	15-146	
16	16.1	14-Feb-92	Downstream	92.3	93.4	82H/12	Female	Young ad.	Good	----	16-147	150.114
16	16.2	28-Feb-92	Downstream	92.3	93.4	82H/12	Recapture				16-147	150.114
17	17	20-Feb-92	Spillway	90.2	93.9	82H/12	Female	Fawn	Good	----	17-148	
18	18	20-Feb-92	Brockwell S.	12.3	101.6	82G/9	Female	Fawn	Good	----	18-149	
19	19	20-Feb-92	Brockwell S.	12.3	101.6	82G/9	Male	Fawn	Good	----	19-150	
20	20	20-Feb-92	Renner South	8.0	98.8	82G/9	Male	Fawn	Good	----	20-151	
21	21.1	20-Feb-92	Renner North	8.0	98.8	82G/9	Female	Yearling	Good	----	21-152	
21	21.2	28-Feb-92	Renner North	8.0	98.8	82G/9	Recapture				21-152	
22	22.1	27-Feb-92	Spillway	90.2	93.9	82H/12	Female	Prime ad.	Medium	----	22-154	150.014
22	22.2	5-Mar-92	Spillway	90.2	93.9	82H/12	Recapture				22-154	
22	22.3	10-Mar-92	Spillway	90.2	93.9	82H/12	Recapture				22-154	
23	23	27-Feb-92	Glass West	92.3	94.5	82H/12	Female	Yearling	Good	8	23-153	
24	24	27-Feb-92	Renner North	8.0	98.8	82G/9	Male	Yearling	Good		24-155	
25	25	28-Feb-92	Brockwell S.	12.3	101.6	82G/9	Female	Young ad.	Good	1	25-156	150.045

26	26	28-Feb-92	Renner South	8.0	98.8	82G/9	Female	Prime ad.	Good	0	26-157	150.055
27	27	28-Feb-92	Renner South	8.0	98.8	82G/9	Female	Fawn	Good	0	27-158	
28	28	4-Mar-92	Island View	10.9	98.4	82G/9	Female	Senior Ad.	Light	3	28-159	148.565
29	29	4-Mar-92	Brockwell S.	12.3	101.6	82G/9	Female	Prime ad.	Good	0	29-160	150.064
30	30	4-Mar-92	Concrete West	9.0	97.6	82G/9	Female	Fawn	Good	0	30-161	
31	31	4-Mar-92	Spillway	90.2	93.9	82H/12	Male	Fawn	Good	3	31-162	
32	32	5-Mar-92	Brockwell S.	12.3	1.6	82G/9	Female	Fawn	Good	3	32-164	
33	33	4-Mar-92	Spillway	90.2	93.9	82H/12	Male	Fawn	Good	3	33-163	
34	34.1	5-Mar-92	Brockwell N.	12.3	1.6	82G/9	Male	Fawn	Very Poor	0	34-165	
34	34.2	7-Mar-92	Brockwell S.	12.3	1.6	82G/9	Recapture				34-165	
34	34.3	10-Mar-92	Brockwell S.	12.3	1.6	82G/9	Recapture				34-165	
34	34.4	13-Mar-92	Brockwell S.	12.3	1.6	82G/9	Recapture				34-165	
35	35	5-Mar-92	Concrete West	9.0	97.6	82G/9	Female	Prime ad.	Good	0	35-166	150.073
36	36.1	5-Mar-92	Concrete West	9.0	97.6	82G/9	Male	Fawn	Good	2	36-167	
36	36.2	7-Mar-92	Renner South	8.0	98.8	82G/9	Recapture				36-167	
37	37.1	5-Mar-92	Renner South	8.0	98.8	82G/9	Female	Fawn	Medium	3	37-168	
37	37.2	10-Mar-92	Renner South	8.0	98.8	82G/9	Recapture				37-168	
38	38	5-Mar-92	Castle West	14.6	90.9	82G/9	Female	Prime ad.	Good	0	38-169	150.083
39	39	6-Mar-92	Renner North	8.0	98.8	82G/9	Female	Fawn	Good	1	39-170	
40	40.1	6-Mar-92	Castle West	9.0	97.6	82G/9	Female	Fawn	Light	7	40-171	
40	40.2	11-Mar-92	Castle West	9.0	97.6	82G/9	Recapture				40-171	
41	41	7-Mar-92	Glass West	92.3	94.5	82H/12	Female	Fawn	Good	1	41-172	
42	42	7-Mar-92	Tennessee	86.9	97.7	82H/12	Female	Young ad.	Good	0	42-173	150.104
43	43	7-Mar-92	Island View	10.9	98.4	82G/9	Female	Fawn	Good	0	43-174	
44	44	10-Mar-92	Renner North	8.0	98.8	82G/9	Male	Fawn	Good	----	44-175	
45	45	10-Mar-92	Renner South	8.0	98.8	82G/9	Female	Prime ad.	Good	0	45-138	150.124
46	46	11-Mar-92	Brockwell S.	12.3	101.6	82G/9	Female	Young ad.	Good	4	46-190	150.156
47	47	11-Mar-92	Renner North	8.0	98.8	82G/9	Female	Young ad.	Good	4	47-191	150.164
48	48	11-Mar-92	Castle East	15.0	91.1	82G/9	Female	Fawn	Good	----	48-192	
49	49	13-Mar-92	Tennessee	86.9	97.7	82H/12	Male	Fawn	Medium	1	49-192	
50	50	13-Mar-92	Concrete West	9.0	97.6	82G/9	Male	Fawn	Good	1	50-194	
51	Y4	1-Dec-93	Castle River	17.1	93.2	82G/9	Female	Adult	no capture data		Y4	150.184
52	Y6	1-Dec-93	Castle River	16.4	95.9	82G/9	Female	Adult	no capture data		Y6	
53	Y7	1-Dec-93	Cowley	14.8	94.0	82G/9	Male	Adult	no capture data		Y7	
54	Y8	1-Dec-93	Cowley	14.8	94.0	82G/9	Female	Adult	no capture data		Y8	150.036
55	1.1	26-Jan-94	Lookout	90.8	93.2	82H/12	Female	Adult	Good	0	51	150.205
56	2.1	26-Jan-94	Tennessee	86.9	97.7	82H/12	Male	Fawn	Good	0	52	----
57	3.1	27-Jan-94	Renner's	8.0	98.8	82G/9	Male	Yearling	Poor	0	53	----
58	4.1	27-Jan-94	Lookout	90.8	93.2	82H/12	Female	Young ad.	Medium	0	54	150.555
59	5.1 (39)	1-Feb-94	Cowley Bdg	11.0	98.5	82G/9	Female	Adult	Good	0	39	150.263
60	6.1	27-Jan-94	Horseshoe	16.7	96.2	82G/9	Female	Adult	Good	0	55	150.303
61	7.1	2-Feb-94	Horseshoe	16.7	96.2	82G/9	Male	Fawn	----	----	----	----
62	8.1	2-Feb-94	Stevick's	14.8	91.7	82G/9	Female	Fawn	Good	0	56	----
63	9.1	2-Feb-94	Cowley Bdg	11.0	98.5	82G/9	Male	Young ad.	Good	0	57	150.023
64	10.1	4-Feb-94	Stevick's	14.8	91.7	82G/9	Female	Prime ad.	Good	0	59	150.295
65	11.1	4-Feb-94	Cemetery	9.9	97.2	82G/9	Female	Prime ad.	Fair	0	60	150.314
66	12.1	8-Feb-94	Cowley Bdg	11.0	98.5	82G/9	Male	Fawn	Good	0	58	----
67	13.1	8-Feb-94	Schatz	84.4	95.5	82H/12	Female	Fawn	Good	0	61	----
68	14.1	9-Feb-94	Johnson's	11.8	102.7	82G/9	Female	Young ad.	Good	0	62	150.194
69	15.1	10-Feb-94	Horseshoe	16.7	96.2	82G/9	Male	Fawn	Good	0	63	----
70	16.1	11-Feb-94	North Fork	12.2	101.3	82G/9	Male	Fawn	Fair	0	64	----
71	17.1	11-Feb-94	Cemetery	9.9	97.2	82G/9	Male	Young ad.	Fair	0	65	150.005
72	18.1	15-Feb-94	Horseshoe	16.7	96.2	82G/9	Male	Fawn	Medium	0	66	----
73	19.1	16-Feb-94	Johnson's	11.8	102.7	82G/9	Male	Fawn	Good	0	67	----
74	20.1	16-Feb-94	Horseshoe	16.7	96.2	82G/9	Male	Fawn	Good	0	68	----
75	21.1	16-Feb-94	Horseshoe	16.7	96.2	82G/9	Female	Fawn	Medium	1	69	----
76	70	19-Jan-96	Cemetery	9.9	97.2	82G/9	Female	Young ad.	Good	unkn	70	148.565

77	71	31-Jan-96	Cowley Bridge	11.0	98.5	82G/9	Male	Yearling	unkn	unkn	71	
78	72	23-Jan-96	Cemetery	9.9	97.2	82G/9	Male	Fawn	Medium	unkn	72	
79	73	6-Feb-96	Glass Prop.	92.3	94.5	82H/12	Male	Fawn	Good	0	73	
80	74	7-Feb-96	Todd Creek	8.0	98.9	82G/9	Female	Young ad.	Good	0	74	no radio
81	75	8-Feb-96	Threshing	92.3	94.7	82H/12	Female	Fawn	Good	0	75	
85	Y10	8-Feb-96	Threshing	92.3	94.7	82H/12	Male	Fawn	Good	0	Y10	
82	Y11	14-Feb-96	Threshing	92.3	94.7	82H/12	Female	Yearling	Good	0	Y11	
86	Y12	15-Feb-96	Stevik's	14.8	91.7	82G/9	Male	Fawn	Good	some	Y12	
87	Y13	27-Feb-96	Glass Prop.	92.3	94.5	82H/12	Male	Adult	Good	unkn	Y13	150.014
84	Y14	29-Feb-96	Threshing	92.3	94.7	82H/12	Female	Fawn	Good	unkn	Y14	
83	Y15	29-Feb-96	Gravel Pile	84.4	99.1	82H/12	Female	Young ad.	Good	3	Y15	150.563

Age class was assigned based on tooth replacement and wear.
General body condition was assessed on the basis of subcutaneous fat reserves on ribs and pelvic girdle.
Ticks are presumed to be the winter tick, Dermacentor albipictus.

Appendix Table 7.3 Physical measurements of mule deer (Odocoileus virginianus) capture at the Oldman River Dam, southwestern Alberta.

Deer No.	Capture Date	Sex	Age Class	Chest Girth	Weight (kg)	Weight (lbs.)	Head Length	Neck Circum.	Tarsal bone Length	Tarsal gland Length	Shoulder Height	Chest Height
7	Feb '92	Female	Prime adult	100.33	67.60	149.00	34.50	38.00	40.50		96.50	53.30
22	Mar '92	Female	Prime adult	101.00	71.20	157.00	33.00	35.00	44.00		102.00	63.50
26	Feb '92	Female	Prime adult	97.00	64.40	142.00	30.00	36.00	44.50		99.00	58.00
29	Mar '92	Female	Prime adult	97.20	59.90	132.00	29.80	36.80	41.30		87.60	48.30
35	Mar '92	Female	Prime adult	98.20	60.80	134.00	31.80	36.20	41.90		92.70	53.30
38	Mar '92	Female	Prime adult	95.90	63.10	139.00	31.80	35.60	43.20		87.60	53.30
45	Mar '92	Female	Prime adult	107.00	75.70	167.00	32.00	36.00	43.50		96.00	57.00
13	Feb '92	Female	Senior adult		71.20	157.00	32.00	38.00	43.50		92.00	49.00
28	Mar '92	Female	Senior adult	96.50	68.00	151.00	32.50	36.80	44.50		100.30	63.50
25	Feb '92	Female	Young adult	93.00	61.70	136.00	30.00	34.00	42.00		96.00	60.00
42	Mar '92	Female	Young adult	91.40	56.70	125.00	29.20	34.30	40.60		87.60	54.60
6	Feb '92	Female	Young adult	100.00	64.90	143.00	31.00	39.00	40.00		91.00	54.00
8	Feb '92	Female	Young adult	88.90	56.70	125.00	29.20	34.30	43.20		96.50	55.90
16	Feb '92	Female	Young adult	100.00	67.60	149.00	29.00	41.00	42.50		92.00	52.00
46	Mar '92	Female	Young adult	98.50	67.10	148.00	30.00	34.00	43.50		102.00	62.00
47	Mar '92	Female	Young adult	106.00	72.60	160.00	31.00	33.50	43.00		103.50	60.00
39	Feb '94	Female	Adult	100.00	59.42	131.00	30.50	35.00	43.00	15.00	90.00	55.00
51	Jan '94	Female	Adult	102.00	68.95	152.00	32.00	39.00	44.00	11.00	95.00	
54	Jan '94	Female	Adult	138.00	59.42	131.00	25.50	39.00	41.00	14.00	93.50	51.00
55	Jan '94	Female	Adult	98.00	62.14	137.00	28.50	41.00	42.00	16.00	87.00	48.00
59	Feb '94	Female	Adult	100.00	66.23	146.00	32.50	40.00	42.50	15.00	89.00	48.00
60	Feb '94	Female	Adult	99.00	63.96	141.00	28.00	36.50	44.00	15.00	95.00	52.00
62	Feb '94	Female	Adult	102.00	63.05	139.00	30.00	39.00	43.50	16.00	91.50	56.00
70	Jan '96	Female	Young adult	112.00	83.90	185.00	37.50	45.00	44.50	14.00	92.00	49.00
74	Feb '96	Female	Young adult	110.00	71.20	157.00	29.00	44.50	37.00	15.00	85.00	43.50
Y15	Feb '96	Female	Young adult	97.00	58.50	129.00	28.50	45.00	42.50	17.00	84.00	52.00
			Sample size	25.00	26.00	26.00	26.00	26.00	26.00	10.00	26.00	25.00
			Sqr N	5.00	5.10	5.10	5.10	5.10	5.10	3.16	5.10	5.00
			Mean	101.16	65.61	144.69	30.72	37.79	42.53	14.80	93.24	54.09
			Std. Dev.	9.27	6.30	13.93	2.34	3.38	1.71	1.62	5.34	5.15
			Std. Error	1.85	1.24	2.73	0.46	0.66	0.33	0.51	1.05	1.03
1	Feb '92	Female	Yearling	84.00	39.00	86.00	25.00	32.00	38.00		83.00	43.00
4	Feb '92	Female	Yearling	79.00	38.10	84.00	23.50	32.00	30.00		80.00	52.00
21	Feb '92	Female	Yearling	85.10	44.40	98.00	26.70	31.80	40.60		90.20	58.40
23	Feb '92	Female	Yearling	83.00	39.00	86.00	25.00	29.00	42.00		83.00	46.00
Y11	Feb '96	Female	Yearling	99.00	60.80	134.00	26.00	41.00	43.00	13.00	77.00	51.50
			Sample size	5.00	5.00	5.00	5.00	5.00	5.00	1.00	5.00	5.00
			Sqr N	2.24	2.24	2.24	2.24	2.24	2.24	1.00	2.24	2.24
			Mean	86.02	44.26	97.60	25.24	33.16	38.72	13.00	82.64	50.18
			Std. Dev.	7.61	9.58	21.09	1.21	4.56	5.22		4.90	5.95
			Std. Error	3.40	4.28	9.43	0.54	2.04	2.34		2.19	2.66
57	Feb '94	Male	Young adult	110.00	67.59	149.00	24.00	44.00	44.00	16.00	94.00	56.00
65	Feb '94	Male	Young adult	106.00	74.39	164.00	32.00	42.00	46.50	13.00	115.00	58.00
Y13	Feb '96	Male	Adult	106.00	75.80	167.00	31.50	50.50	46.00	16.50	96.00	49.00

			Sample size	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
			Sqr N	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73
			Mean	107.33	72.59	160.00	29.17	45.50	45.50	15.17	101.67	54.33
			Std. Dev.	2.31	4.39	9.64	4.48	4.44	1.32	1.89	11.59	4.73
			Std. Error	1.33	2.54	5.57	2.59	2.57	0.76	1.09	6.69	2.73
2	Feb '92	Female	Fawn	77.00	34.90	77.00	24.00	28.00	37.00		80.00	51.00
3	Feb '92	Female	Fawn	73.00	34.90	77.00	23.00	29.00	36.00		77.00	47.00
5	Feb '92	Female	Fawn	70.00	30.80	68.00	22.00	27.00	36.00		79.00	56.00
10	Feb '92	Female	Fawn	77.00	28.10	62.00	26.00	31.00	38.00		82.00	47.00
12	Feb '92	Female	Fawn	79.00	34.90	77.00	23.50	31.00	37.00		81.00	48.00
14	Feb '92	Female	Fawn	80.00	34.90	77.00	24.00	28.00	39.00		83.00	46.00
18	Feb '92	Female	Fawn	80.80	36.30	80.00	25.40	31.80	38.10		80.00	49.50
27	Feb '92	Female	Fawn	82.00	42.20	93.00	27.00	29.00	41.50		91.00	50.00
30	Mar '92	Female	Fawn	78.80	33.10	73.00	24.10	28.60	38.10		48.30	48.30
32	Mar '92	Female	Fawn	75.60	33.10	73.00	24.10	29.20	37.50		73.70	48.30
37	Mar '92	Female	Fawn	80.60	37.20	82.00	26.10	31.10	39.40		84.40	55.90
39	Mar '92	Female	Fawn	82.60	36.70	81.00	26.70	31.80	39.40		85.10	53.30
40	Mar '92	Female	Fawn	74.90	30.40	67.00	24.80	31.80	38.10		81.30	53.30
41	Mar '92	Female	Fawn	78.70	35.80	79.00	25.40	31.10	38.70		78.70	49.50
43	Mar '92	Female	Fawn	80.00	37.60	83.00	26.00	29.80	39.40		76.20	48.30
48	Mar '92	Female	Fawn	78.00	34.90	77.00	25.00	27.50	39.00		86.00	56.00
56	Feb '94	Female	Fawn	80.00	36.74	81.00	24.50	30.00	39.00	13.50	80.00	49.00
61	Feb '94	Female	Fawn	81.00	37.65	83.00	26.00	32.00	39.00	12.00	81.00	52.00
69	Feb '94	Female	Fawn	85.00	38.56	85.00	25.50	32.00	40.50	12.00	83.00	49.00
75	Feb '96	Female	Fawn	83.00	43.50	96.00	23.00	36.50	40.00	12.00	75.00	43.50
Y14	Feb '96	Female	Fawn	84.00	35.80	79.00	25.50	42.00	38.00	16.00	80.50	44.50
			Sample size	21.00	21.00	21.00	21.00	21.00	21.00	5.00	21.00	21.00
			Sqr N	4.58	4.58	4.58	4.58	4.58	4.58	2.24	4.58	4.58
			Mean	79.10	35.62	78.57	24.84	30.87	38.51	13.10	79.34	49.78
			Std. Dev.	3.65	3.53	7.79	1.31	3.32	1.37	1.75	8.11	3.57
			Std. Error	0.80	0.77	1.70	0.29	0.72	0.30	0.78	1.77	0.78
11	Feb '92	Male	Fawn	87.00	46.50	102.00	26.00	33.00	40.00		90.00	58.00
15	Feb '92	Male	Fawn	76.00	34.50	76.00	24.00	28.00	40.00		81.00	48.00
17	Feb '92	Male	Fawn	77.50	36.70	81.00	25.40	30.50	40.50		83.80	52.00
19	Feb '92	Male	Fawn	83.80	37.20	82.00	25.40	33.00	38.10		81.30	47.00
20	Feb '92	Male	Fawn	83.80	41.30	91.00	27.90	33.00	41.90		87.60	52.10
31	Mar '92	Male	Fawn	86.40	39.00	86.00	26.70	31.10	39.40		83.80	53.30
33	Mar '92	Male	Fawn	78.70	33.10	73.00	24.10	32.40	35.60		72.40	40.60
34	Mar '92	Male	Fawn	76.20	32.20	71.00	26.70	33.70	39.40		80.00	50.80
36	Mar '92	Male	Fawn	81.90	33.60	74.00	25.40	31.10	38.70		81.30	50.80
44	Mar '92	Male	Fawn	82.00	41.30	91.00	26.00	31.50	41.00		84.00	47.50
49	Mar '92	Male	Fawn	75.00	33.60	74.00	24.50	29.50	37.00		77.00	46.00
50	Mar '92	Male	Fawn	82.50	40.40	89.00	25.50	29.00	39.00		85.00	47.00
52	Jan '94	Male	Fawn	80.00	38.10	84.00	23.50	31.00	38.50	11.00	77.00	43.00
58	Feb '94	Male	Fawn	84.00	38.56	85.00	24.00	33.00	41.00	11.00	80.00	48.00
63	Feb '94	Male	Fawn	88.00	43.55	96.00	26.00	36.50	41.00	11.00	90.00	48.00
64	Feb '94	Male	Fawn	88.00	48.08	106.00	28.00	36.00	41.00	12.50	92.00	54.50
66	Feb '94	Male	Fawn	86.00	44.00	97.00	26.50	35.50	44.00	11.00	93.00	57.50
67	Feb '94	Male	Fawn	89.00	39.01	86.00	24.50	34.00	41.50	12.50	81.50	46.00
68	Feb '94	Male	Fawn	84.00	36.29	80.00	26.00	35.00	38.00	13.00	78.00	45.00
----	Feb '94	Male	Fawn		34.93	77.00	25.00	38.00	40.00	12.00	80.00	49.00
72	Jan '96	Male	Fawn	85.00	39.00	86.00	22.50	38.00	40.00	10.00	81.00	52.00
73	Feb '96	Male	Fawn	95.00	36.30	80.00	24.00	40.00	40.50	13.00	81.00	41.50
Y10	Feb '96	Male	Fawn	90.50	46.70	103.00	25.00	40.80	40.50	13.00	80.00	52.00

Y12	Feb '96	Male	Fawn	91.00	38.10	84.00	26.00	40.50	38.00	9.50	77.50	40.00
			Sample size	23.00	24.00	24.00	24.00	24.00	24.00	12.00	24.00	24.00
			Sqr N	4.80	4.90	4.90	4.90	4.90	4.90	3.46	4.90	4.90
			Mean	83.97	38.83	85.58	25.36	33.92	39.78	11.63	82.43	48.73
			Std. Dev.	5.19	4.46	9.79	1.33	3.62	1.76	1.21	5.08	4.82
			Std. Error	1.08	0.91	2.00	0.27	0.74	0.36	0.35	1.04	0.98
9	Feb '92	Male	Yearling	96.50	61.00	135.00	29.00	38.10	44.50		99.00	61.00
24	Feb '92	Male	Yearling	96.00	57.00	126.00	29.00	36.00	46.00		93.00	46.00
53	Jan '94	Male	Yearling	138.00	46.72	103.00	31.00	39.50	46.00	12.50	91.00	56.00
71	Jan '96	Male	Yearling	102.00	59.90	132.00	29.00	48.00	42.00	12.00	86.00	56.00
			Sample size	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00	4.00
			Sqr N	2.00	2.00	2.00	2.00	2.00	2.00	1.41	2.00	2.00
			Mean	108.13	56.16	124.00	29.50	40.40	44.63	12.25	92.25	54.75
			Std. Dev.	20.10	6.51	14.49	1.00	5.27	1.89	0.35	5.38	6.29
			Std. Error	10.05	3.26	7.25	0.50	2.63	0.94	0.25	2.69	3.15

Appendix Table 7.4 Number of mule deer relocations at the Oldman River Dam by individual deer no. and divided among seasonal periods.

		Seasonal Period							Seasonal Period				
Deer No.	Year	Winter (Dec-Mar)	Spring (Apr-May)	Summer (Jun-Sep)	Fall (Oct-Nov)	Total	Deer No.	Year	Winter (Dec-Mar)	Spring (Apr-May)	Summer (Jun-Sep)	Fall (Oct-Nov)	Total
6	1991-92	6	11	16	2	35	16	1991-92	5	12	13	1	31
6	1992-93	10		4		14	16	1992-93	8		2		10
6	1993-94	3		3		6	16	1993-94	5		2	1	8
6	1994-95	1		14	2	17	16	1994-95	4		9		13
	Subtotal					72	16	1995-96	5	1			6
								Subtotal					68
7	1991-92	4	13	11	4	32							
7	1992-93	12		4		16	22	1991-92	4	13	14	4	35
7	1993-94	8		5		13	22	1992-93	10		6		16
	Subtotal					61	22	1993-94	12		6	1	19
							22	1994-95	5	1			6
8	1991-92	4	13	14	4	35		Subtotal					76
8	1992-93	10		7		17							
8	1993-94	10		11	2	23	25	1991-92	4	11	12	4	31
8	1994-95	8	2	10	3	23	25	1992-93	11		2		13
8	1995-96	11	1		1	13	25	1993-94	8		2		10
	Subtotal					111	25	1994-95	5		4	3	12
							25	1995-96	8		2		10
13	1991-92	4	11	13	4	32		Subtotal					76
13	1992-93	9		4		13							
13	1993-94	9		4		13	26	1991-92	5	14	14	3	36
13	1994-95	2				2	26	1992-93	12		4		16
	Subtotal					60	26	1993-94	9		3	2	14
							26	1994-95	7		14	1	22
								Subtotal					88
28	1991-92	4	12	14	2	32	42	1991-92	4	13	14	4	35
28	1992-93	8		1		9	42	1992-93	10		5		15
28	1993-94	2		1		3	42	1993-94	5		9		14
	Subtotal					44		Subtotal					64
29	1991-92	4	11	9	4	28	45	1991-92	3	13	14	4	34
29	1992-93	11		2		13							
29	1993-94	5		3	1	9	46	1991-92	3	14	18	3	38
29	1994-95	4				4	46	1992-93	10		4	1	15
	Subtotal					54		Subtotal					53
35	1991-92	4	12	15	2	33	47	1991-92	3	11	15	4	33
35	1992-93	12		5		17	47	1992-93	12		6		18
35	1993-94	2		3	3	8	47	1993-94	6		8	4	18

35	1994-95	7		12	4	23
35	1995-96	9	2	4		15
	Subtotal					96
38	1991-92	4	11	14	3	32
38	1992-93	12		4		16
38	1993-94	8		4	3	15
38	1994-95	1	1	9	1	12
38	1995-96	12	1	4	1	18
	Subtotal					93
39	1992-93	1				1
39	1993-94	7		5	1	13
39	1994-95	4	1	7	3	15
39	1995-96	10	2	3		15
	Subtotal					44
59	1993-94	4		4		8
59	1994-95	3	1	10	1	15
59	1995-96	4	2	5	1	12
	Subtotal					35
60	1993-94	5		2	1	8
62	1993-94	4		2		6
62	1994-95	4		8	3	15
62	1995-96	5		2		7
	Subtotal					28
65	1993-94	2	1	2	3	8
70	1995-96	6		2		8
Y4	1992-93	5				5
Y4	1993-94					0
Y4	1994-95		1	8	1	10
Y4	1995-96	9	2	4	1	16
	Subtotal					31

47	1994-95	10		10	5	25
47	1995-96	9	2	5		16
	Subtotal					110
51	1993-94	12		7	1	20
51	1994-95	6	1	12	2	21
51	1995-96	11	3		1	15
	Subtotal					56
54	1993-94	10		3		13
55	1993-94	4		4	3	11
57	1993-94	7		1	1	9
57	1994-95	1	1			2
	Subtotal					11
Y6	1991-92	1				1
Y6	1992-93			1		1
	Subtotal					2
Y7	1992-93	3				3
Y8	1992-93	10		4		14
Y8	1993-94	5		2	1	8
Y8	1994-95	5	1	1		7
Y8	1995-96	9	1	2		12
	Subtotal					41
Y11	1995-96	2				2
Y13	1995-96	4	2			6
Y15	1995-96	3	1			4

Appendix Table 7.5 List of known mortalities of mule deer at the Oldman River Dam, identified by cause and distance from capture.

Rec. No.	Deer No.	Sex/ Age when Captured	Radio-collar Freq. (MHz)	Date of Capture	Date of Mortality	No. of Years with radio	Dist. from Capture (km)
Accidental Mortality							
1	Female #42	Female, adult	150.104	7-Mar-92	15-Sep-94	2.53	5.12
	(appeared to have died with one front leg caught in the loop of radio-collar)						
Harvested under license (n = 7)							
1	Female #2	Female, fawn	Ear tagged	5-Feb-92	4-Nov-93	1.75	2.90
2	Female #6	Female, adult	148.731	6-Feb-92	26-Nov-95	3.81	17.60
3	Male #9	Male yrl	Ear tagged	12-Feb-92	9-Nov-92	0.74	1.56
4	Female #46	Female, adult	150.156	11-Mar-92	6-Nov-93	1.66	2.14
5	Female #55	Female, adult	150.303	2-Feb-94	19-Nov-94	0.79	12.35
6	Female #60	Female, adult	150.314	4-Feb-94	26-Oct-94	0.72	2.00
7	Female #65	Male, adult	150.005	11-Feb-94	8-Nov-94	0.74	1.59
					Mean	1.46	5.73
Killed on road by vehicle collision (n = 4)							
1	Female #3	Female, fawn	Ear tagged	5-Feb-96	7-May-93	1.25	37.85
2	Female #39	Female, fawn	6-Mar-92	1-Feb-94	15-Jun-96	4.28	4.74
3	Male #57	Male, yearling	150.023	2-Feb-94	11-May-95	1.27	7.91
4	Female #Y6	Female, adult	unkn	1-Feb-93	24-Jul-93	0.47	unkn
					Mean	1.82	16.83
Found Dead with no known Cause (n = 9)							
1	Female #7	Female, adult	149.921	10-Feb-92	14-Jul-94	2.42	1.04
2	Female #13	Female, adult	150.095	13-Feb-92	3-Mar-95	3.05	0.98
3	Male #15	Male, fawn	Ear tagged	14-Feb-92	26-Feb-92	0.03	0.67
4	Female #22	Female, adult	150.014	27-Feb-92	6-Apr-95	3.11	1.66
5	Female #26	Female, adult	150.055	28-Feb-92	23-Oct-95	3.65	1.50
6	Female #28	Female, adult	148.565	4-Mar-92	22-Jul-94	2.38	2.63
7	Female #29	Female, adult	150.064	4-Mar-92	23-Jan-95	2.89	0.63
8	Female #54	Female, adult	150.555	27-Jan-94	Jun-94	0.34	8.74
9	Female #Y15	Female, adult	150.563	29-Feb-96	14-May-96	0.21	3.54
					Mean	2.01	2.38
Radio-collared deer Unaccounted for							
1	Female #45	Female, Adult	Radio-collared	10-Mar-92	16-Nov-92	0.69	2.66
		Last relocation was 16 Nov'92.					
Radio-collared Deer Alive at End of Study (n = 13)							
1	8	Female, adult	149.951	11-Feb-92	Alive Dec 1996		
2	16	Female, adult	150.114	14-Feb-92	Alive Dec 1996		
3	25	Female, adult	150.045	28-Feb-92	Alive Dec 1996		
4	35	Female, adult	150.073	5-Mar-92	Alive Dec 1996		
5	38	Female, adult	150.083	5-Mar-92	Alive Dec 1996		
6	47	Female, adult	150.164	11-Mar-92	Alive Dec 1996		
7	51	Female, adult	150.205	26-Jan-94	Alive Dec 1996		
8	59	Female, adult	150.295	4-Feb-94	Alive Dec 1996		
9	62	Female, adult	150.194	9-Feb-94	Alive Dec 1996		
10	70	Female, adult	148.565	19-Jan-96	Alive Dec 1996		
11	Y4	Female, adult	150.184	1-Dec-92	Alive Dec 1996		
12	Y8	Female, adult	150.036	1-Dec-92	Alive Dec 1996		
13	Y13	Male, adult	150.014	27-Feb-96	Alive Dec 1996		

Deer captured and ear-tagged and subsequently no information returned (n = 56)

1	1	Female, yrl	Ear tagged	5-Feb-92
2	3	Female, fawn	Ear tagged	5-Feb-92
3	4	Female, yrl	Ear tagged	6-Feb-92
4	5	Female, fawn	Ear tagged	6-Feb-92
5	9	Male, yrl	Ear tagged	12-Feb-92
6	10	Female, fawn	Ear tagged	12-Feb-92
7	11	Male, fawn	Ear tagged	12-Feb-92
8	12	Female, fawn	Ear tagged	13-Feb-92
9	14	Female, fawn	Ear tagged	14-Feb-92
10	15	Male, fawn	Ear tagged	14-Feb-92
11	17	Female, fawn	Ear tagged	20-Feb-92
12	18	Female, fawn	Ear tagged	20-Feb-92
13	19	Male, fawn	Ear tagged	20-Feb-92
14	20	Male, fawn	Ear tagged	20-Feb-92
15	21	Female, yrl	Ear tagged	20-Feb-92
16	23	Female, yrl	Ear tagged	27-Feb-92
17	24	Male, yrl	Ear tagged	27-Feb-92
18	27	Female, fawn	Ear tagged	28-Feb-92
19	30	Female, fawn	Ear tagged	4-Mar-92
20	31	Male, fawn	Ear tagged	4-Mar-92
21	32	Female, fawn	Ear tagged	5-Mar-92
22	33	Male, fawn	Ear tagged	4-Mar-92
23	34	Male, fawn	Ear tagged	5-Mar-92
24	36	Male, fawn	Ear tagged	5-Mar-92
25	37	Female, fawn	Ear tagged	5-Mar-92
26	39	Female, fawn	Ear tagged	6-Mar-92
27	40	Female, fawn	Ear tagged	6-Mar-92
28	41	Female, fawn	Ear tagged	7-Mar-92
29	43	Female, fawn	Ear tagged	7-Mar-92
30	44	Male, fawn	Ear tagged	10-Mar-92
31	48	Female, fawn	Ear tagged	11-Mar-92
32	49	Male, fawn	Ear tagged	13-Mar-92
33	50	Male, fawn	Ear tagged	13-Mar-92
34	52	Male, fawn	Ear tagged	26-Jan-94
35	53	Male, yrl	Ear tagged	27-Jan-94
36	56	Female, fawn	Ear tagged	2-Feb-94
37	no. x	Male, fawn	Ear tagged	2-Feb-94
38	58	Male, fawn	Ear tagged	8-Feb-94
39	61	Female, fawn	Ear tagged	8-Feb-94
40	63	Male, fawn	Ear tagged	10-Feb-94
41	64	Male, fawn	Ear tagged	11-Feb-94
42	66	Male, fawn	Ear tagged	15-Feb-94
43	67	Male, fawn	Ear tagged	16-Feb-94
44	68	Male, fawn	Ear tagged	16-Feb-94
45	69	Female, fawn	Ear tagged	16-Feb-94
46	71	Male, yrl	Ear tagged	31-Jan-96
47	72	Male, fawn	Ear tagged	23-Jan-96
48	73	Male, fawn	Ear tagged	6-Feb-96
49	74	Female, adult	Ear tagged	7-Feb-96
50	75	Female, fawn	Ear tagged	8-Feb-96
51	Y6	Female, adult	Radio-collared	1-Dec-92
52	Y7	Male, Yrlg	Ear-tagged	1-Dec-92
53	Y10	Male, fawn	Ear tagged	8-Feb-96
54	Y11	Female, fawn	Ear tagged	14-Feb-96
55	Y12	Male, fawn	Ear tagged	15-Feb-96
56	Y14	Female, fawn	Ear tagged	29-Feb-96

Appendix Table 7.6 Population model developed to simulate the effects of observed reproductive/ mortality parameters on population growth.

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500 Input Cohort Size (females at t=0)

60 Cohort Size (Males at t=0)

$R_{doe} = $ **1.326** **Observed average adult Instantaneous Reproductive Rate**

$R_{1.5}, R_{2.5} = 0.850$ Assumed average Instantaneous Rep rate 1.5 and 2.5 yr old

$M_{ff} = $ **0.500** **Observed mortality Female from birth to 0 to 1.5 yrs**

$M_{f1}, M_{f2} = 0.300$ Assumed mortality female from 1.5 to 2.5 yrs and from 2.5 yrs to adult

$M_{doe} = $ **0.180** **Observed adult Female Mortality Rate**

$M_{mf} = $ **0.500** **Observed mortality rate of male from 0 to 1.5 yrs**

$M_{ml}, M_{m2} = 0.800$ Assumed mortality male from 1.5 to 2.5 yrs and from 2.5 yrs to adult

$M_{buck} = 0.800$ Assumed adult male Mortality Rate

	Female				**Male**				**Total Female**	**Total Male**	**Total Pop.**	**% Pop. Change**
TIME YRS	Adult	2.50 yr olds	1.50 yr olds	Fawns	Adult	2.50 yr olds	1.50 yr olds	Fawns				
0	500.00	60.00	90.00	395.25	60.00	20.00	90.00	395.25	1045.25	565.25	1610.50	-
1	452.00	63.00	197.63	410.44	16.00	18.00	197.63	410.44	1123.07	642.07	1765.13	9.60
2	414.74	138.34	205.22	420.98	6.80	39.53	205.22	420.98	1179.28	672.53	1851.81	4.91
3	436.92	143.65	210.49	440.19	9.26	41.04	210.49	440.19	1231.26	700.99	1932.26	4.34
4	458.84	147.34	220.10	460.37	10.06	42.10	220.10	460.37	1286.65	732.63	2019.27	4.50
5	479.39	154.07	230.19	481.14	10.43	44.02	230.19	481.14	1344.78	765.78	2110.56	4.52
6	500.94	161.13	240.57	502.85	10.89	46.04	240.57	502.85	1405.49	800.35	2205.84	4.51
7	523.56	168.40	251.42	525.55	11.39	48.11	251.42	525.55	1468.94	836.47	2305.41	4.51
8	547.20	176.00	262.77	549.27	11.90	50.28	262.77	549.27	1535.25	874.23	2409.48	4.51
9	571.90	183.94	274.64	574.07	12.44	52.55	274.64	574.07	1604.55	913.70	2518.25	4.51
10	597.72	192.25	287.03	599.98	13.00	54.93	287.03	599.98	1676.98	954.94	2631.92	4.51
n	A	B	C	D	E	F	G	H	I	J	K	L

$n = n_{-1} + 1$

$A = (A_{-1} - (A_{-1} * M_{doe})) + (B_{-1} - (B_{-1} * M_{f2}))$

$B = C_{-1} - (C_{-1} * M_{f1})$

$C = D_{-1} - (D_{-1} * M_{ff})$

$D = ((A_{-1} * R_{doe}) + (B_{-1} * R_{2.5}) + (C_{-1} * R_{1.5}))/2$

$E = (E_{-1} - (E_{-1} * M_{buck})) + (F_{-1} - (F_{-1} * M_{m2}))$

$F = G_{-1} - (G_{-1} * M_{ml})$

$G = H_{-1} - (H_{-1} * M_{mf})$

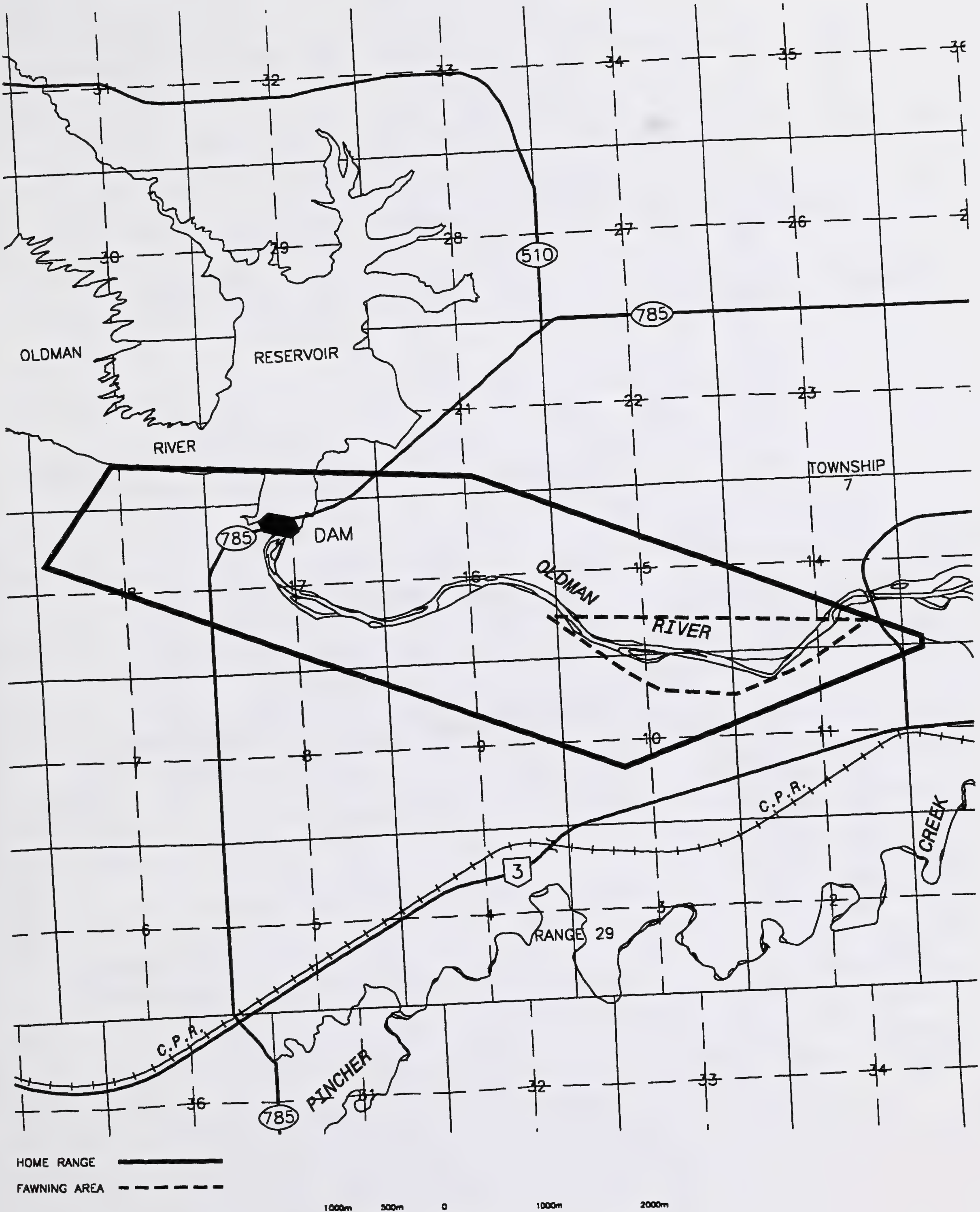
$H = D$

$I = A + B + C + D$

$J = E + F + G + H$

$K = I + J$

$L = ((K / K\text{-}1) * 100) - 100$



ENVIRONMENTAL PROTECTION

NATURAL RESOURCES SERVICE – PRAIRIE REGION

OPERATIONAL SUPPORT BRANCH

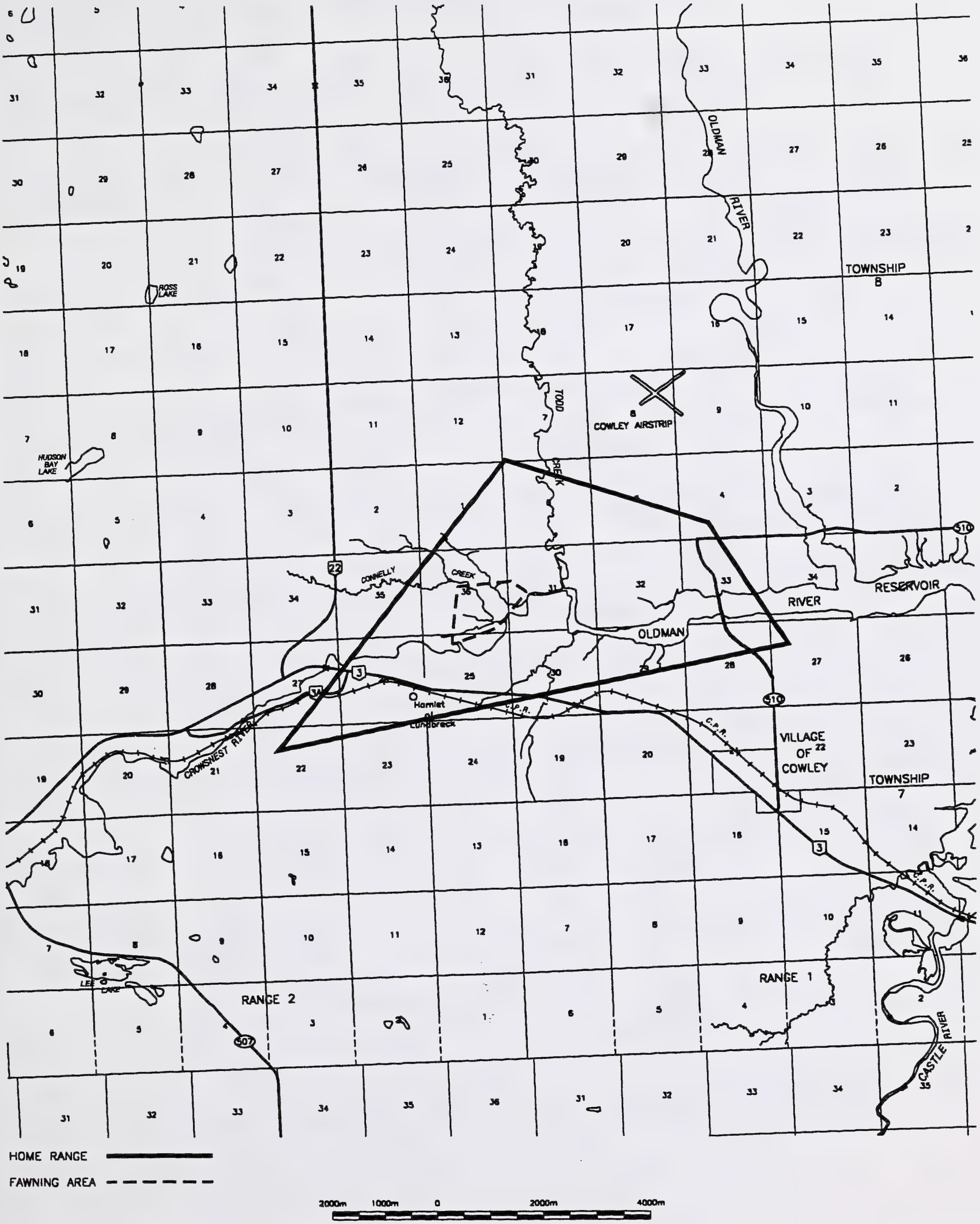
DRAWN: KTF; JANUARY, 1998

OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 6

Tp 7 R 29 W4

Figure No 7 7 1



Alberta
ENVIRONMENTAL PROTECTION
NATURAL RESOURCES SERVICE – PRAIRIE REGION
OPERATIONAL SUPPORT BRANCH

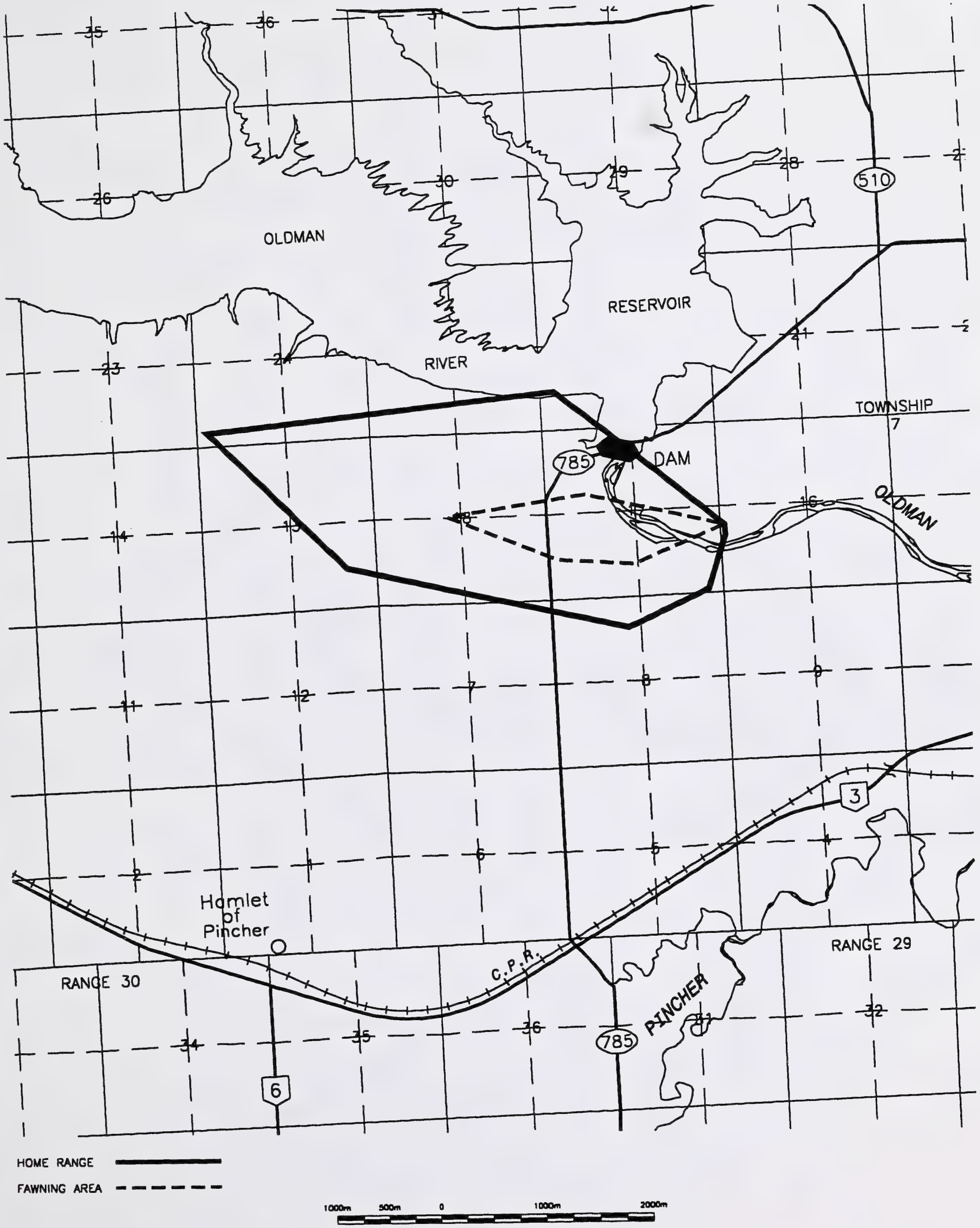
DRAWN: KTF; JANUARY, 1998

OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 7

Tp 7 and 8 R 1 and 2 W5

Figure No 7 7 2



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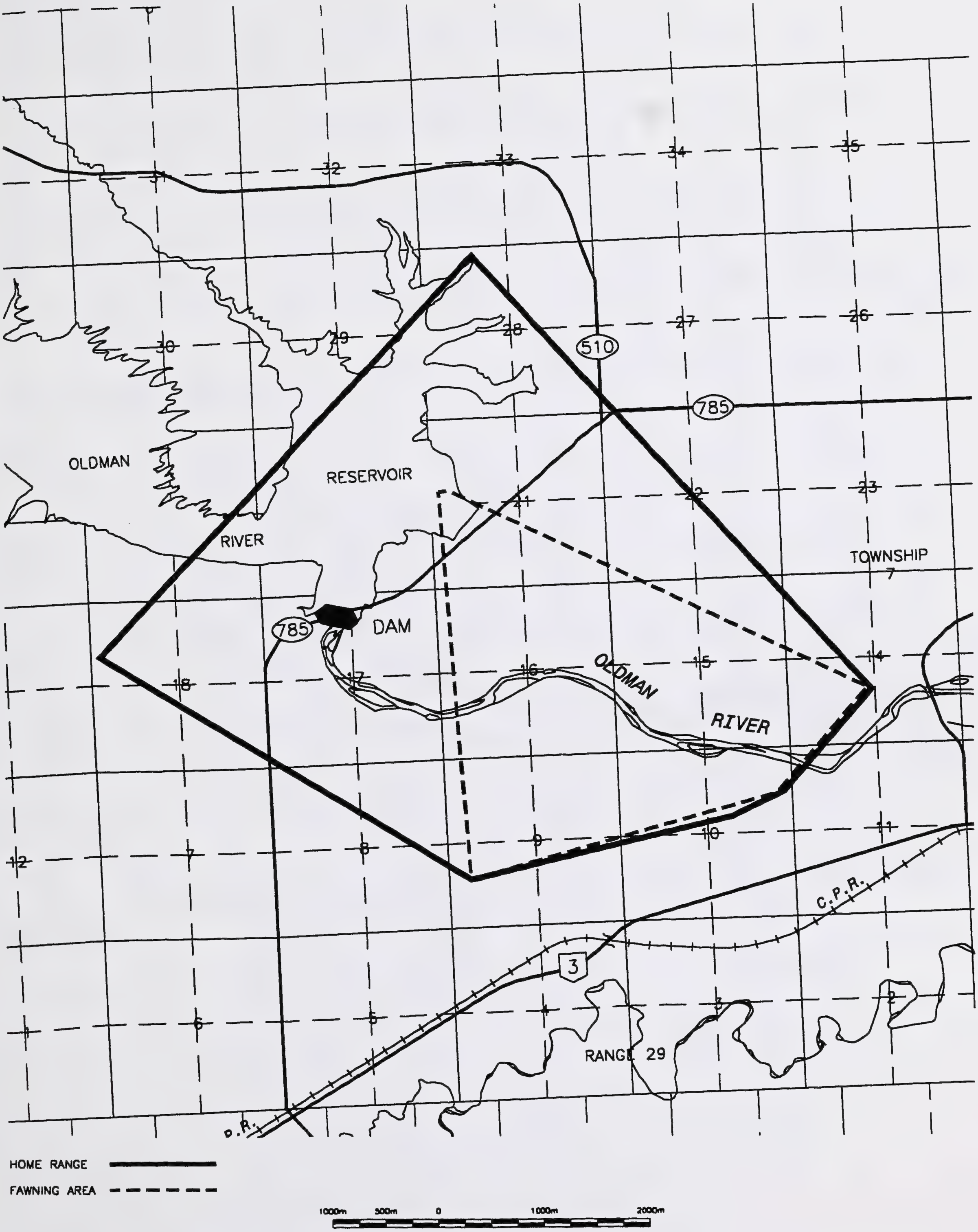
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 8

Tp 7 R 29 and 30 W4

Figure No 7 7 3



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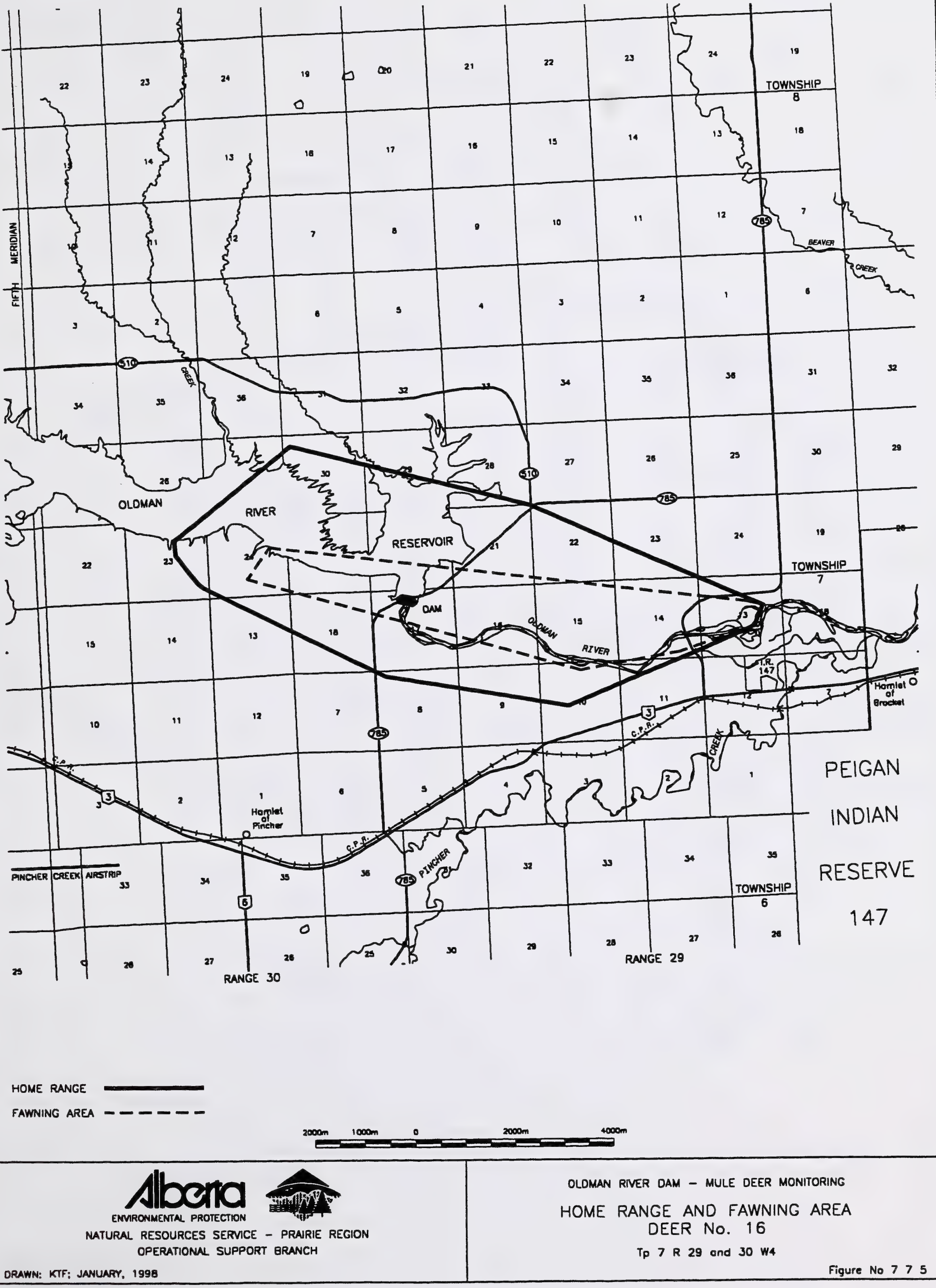
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 13

Tp 7 R 29 W4

Figure No 7 7 4



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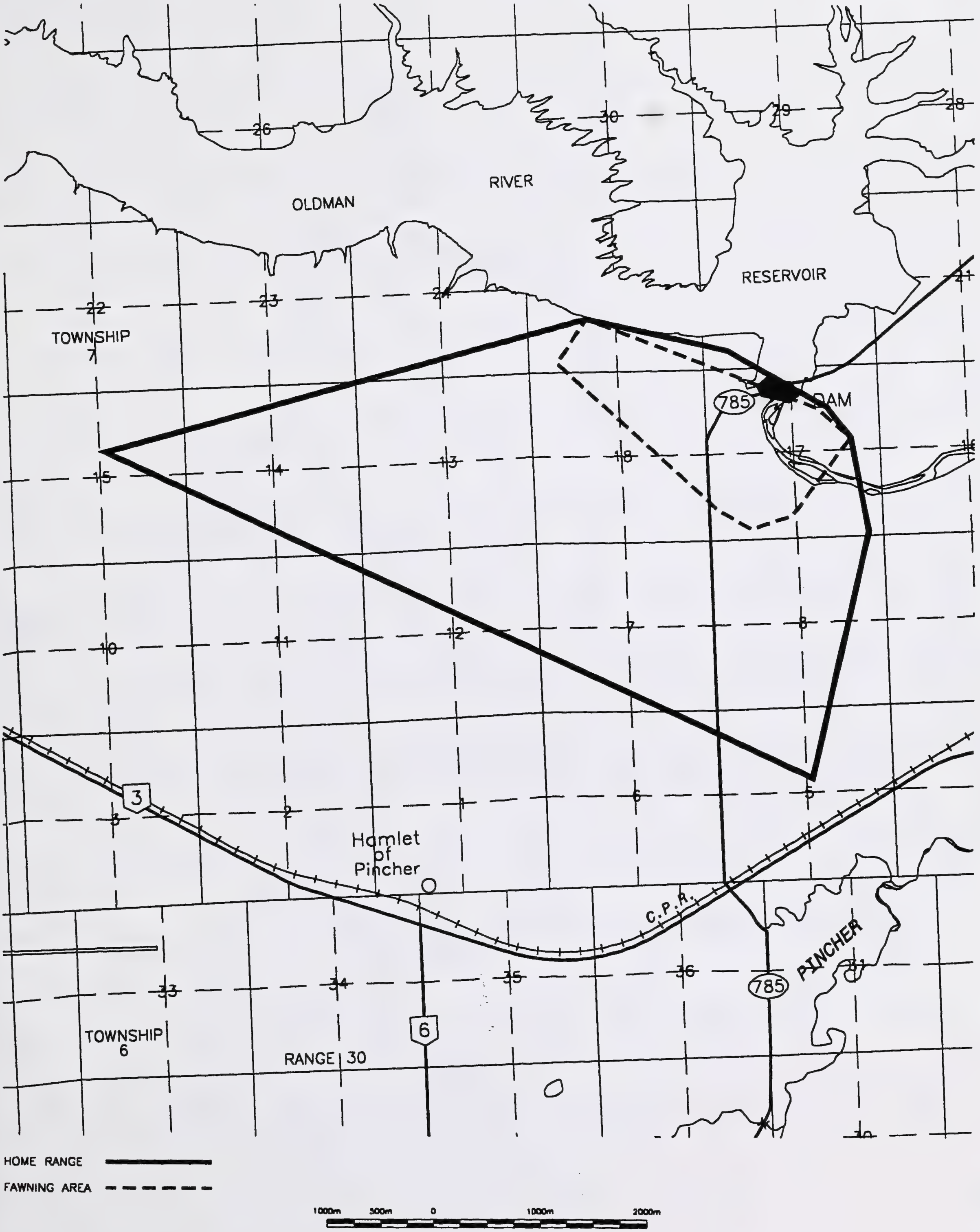
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 16

Tp 7 R 29 and 30 W4

Figure No 7 7 5



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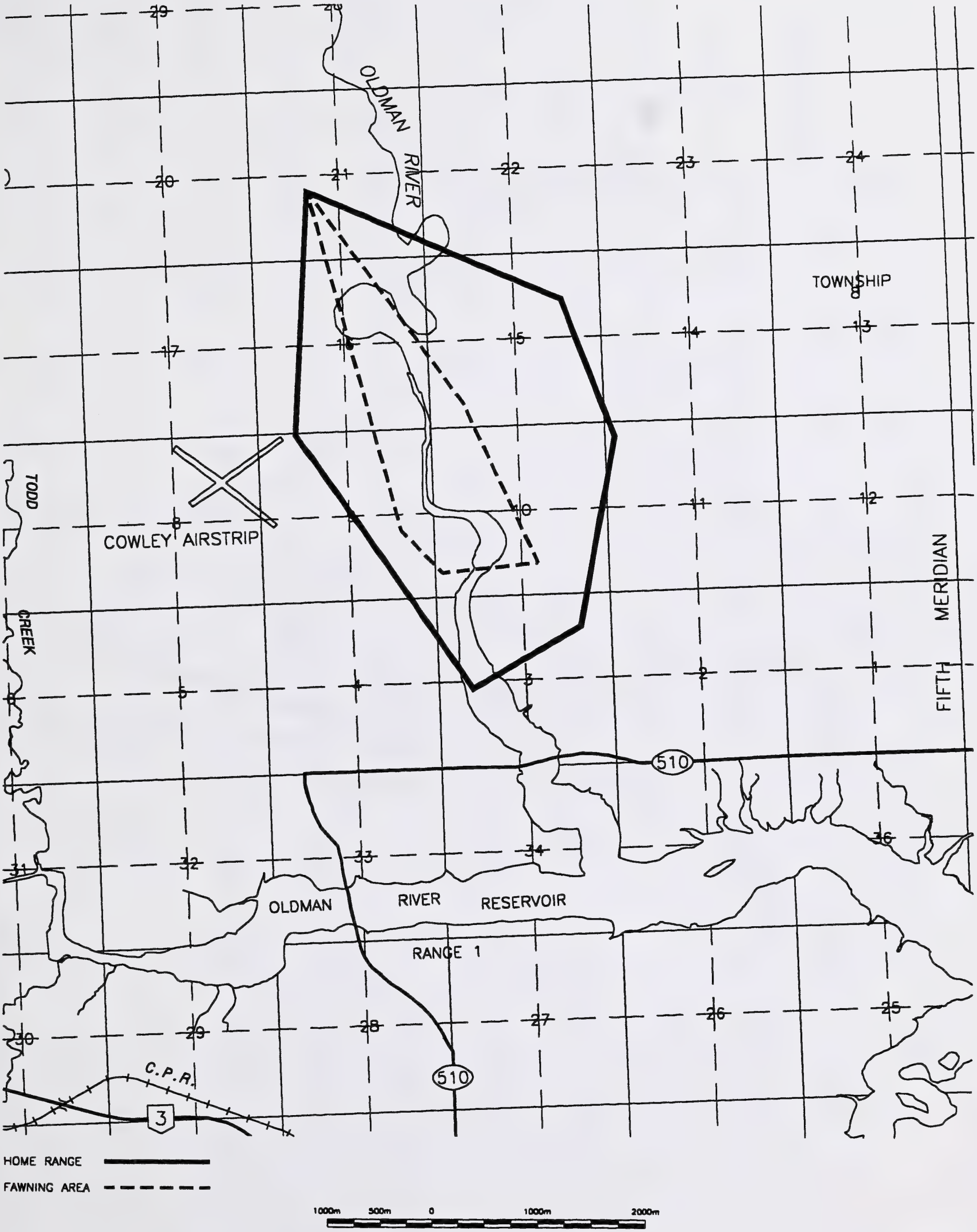
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 22

Tp 7 R 29 and 30 W4

Figure No 7 7 6



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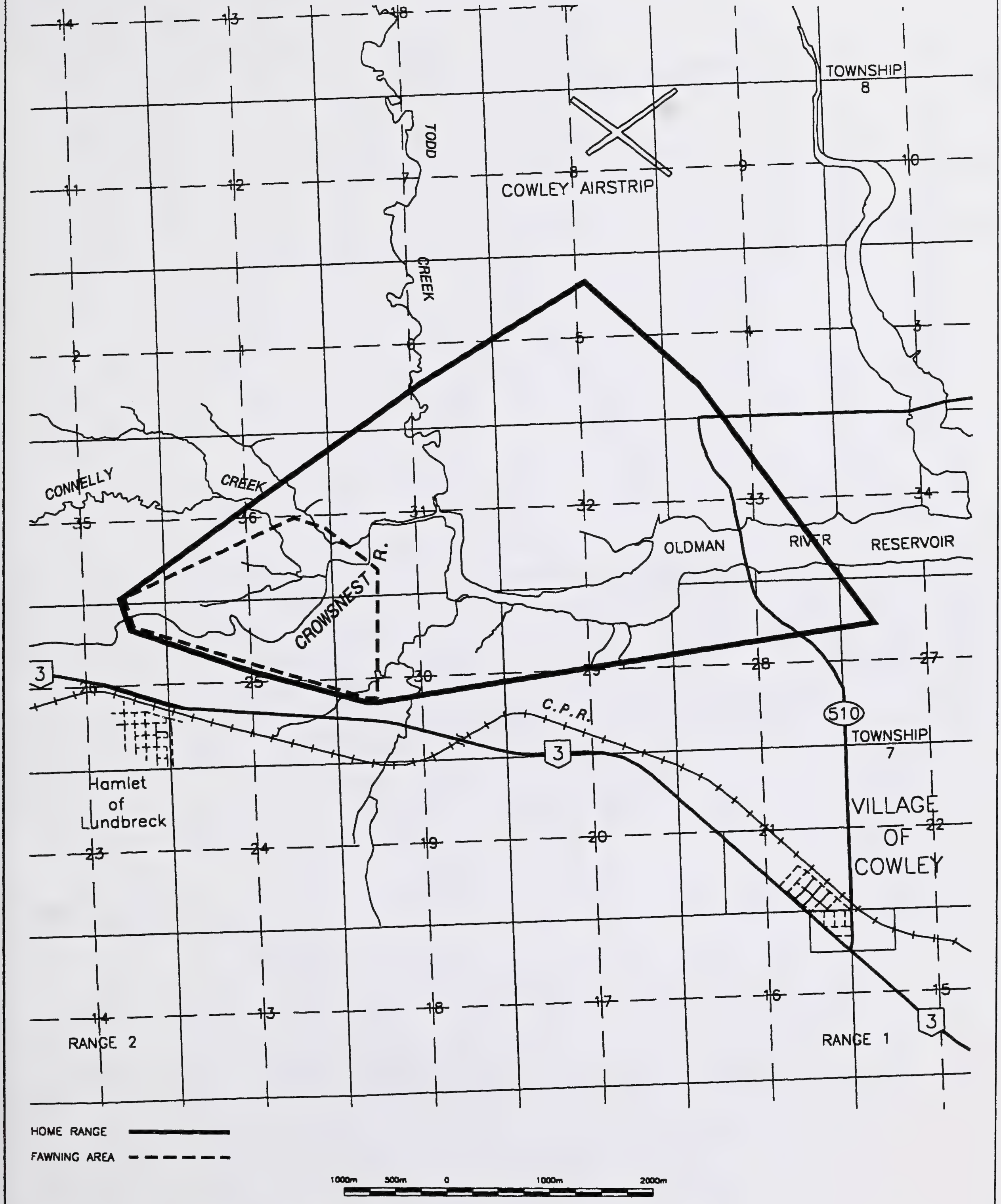
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 25

Tp 8 R 1 W5

Figure No 7 7 7



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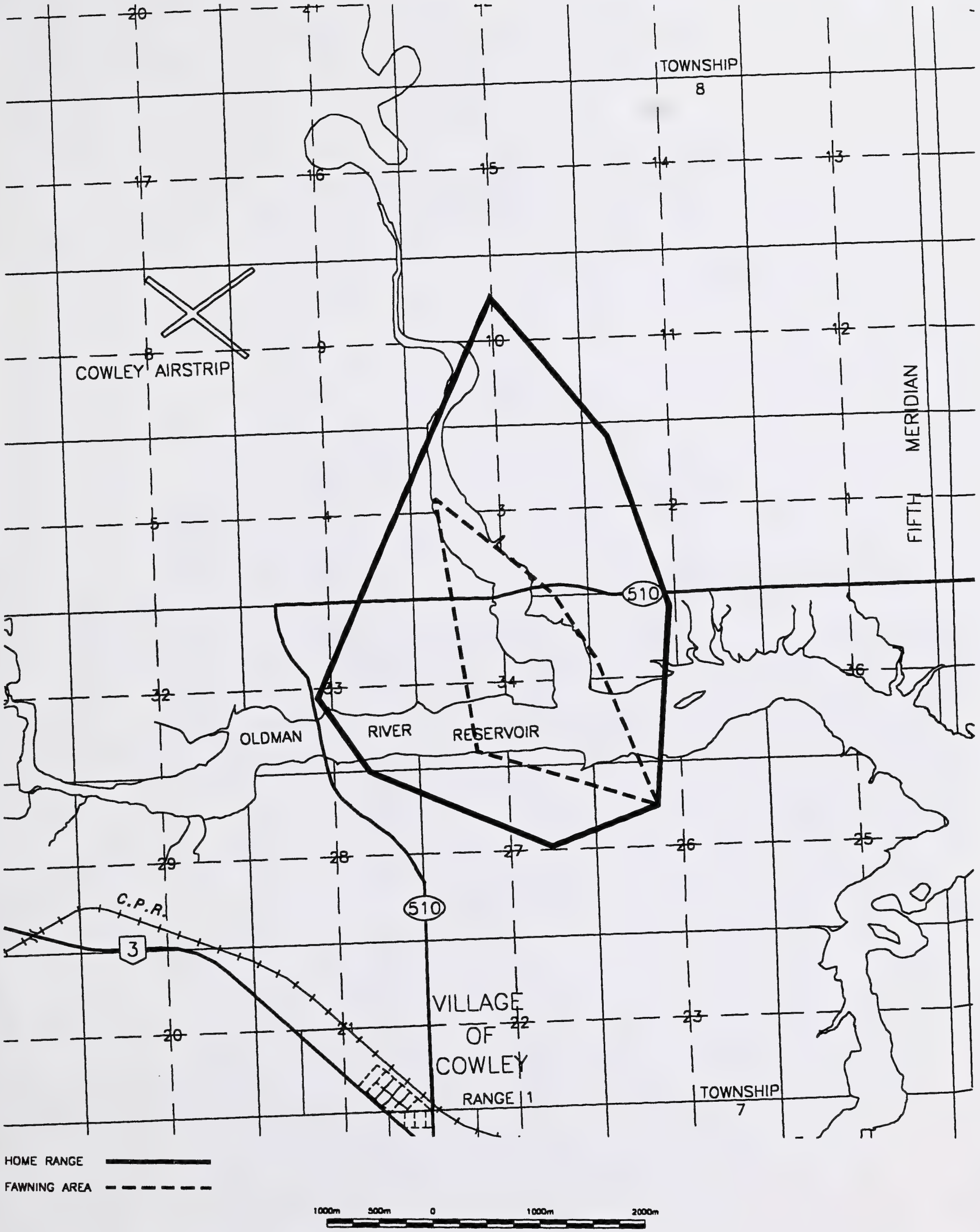
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 26

Tp 7 and 8 R 1 and 2 W5

Figure No 7 7 8



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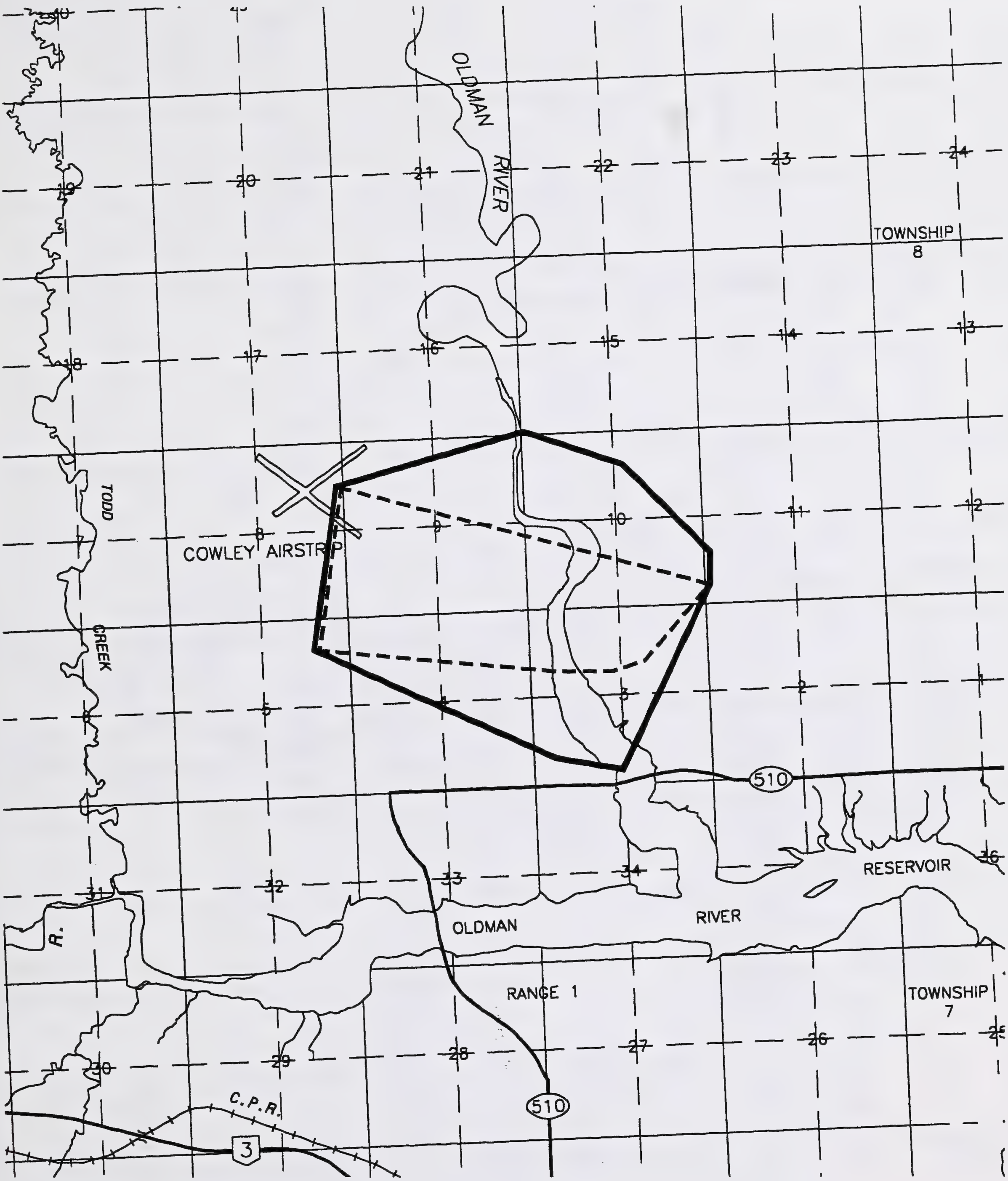
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 28

Tp 7 and 8 R 1 W5

Figure No 7 7 9



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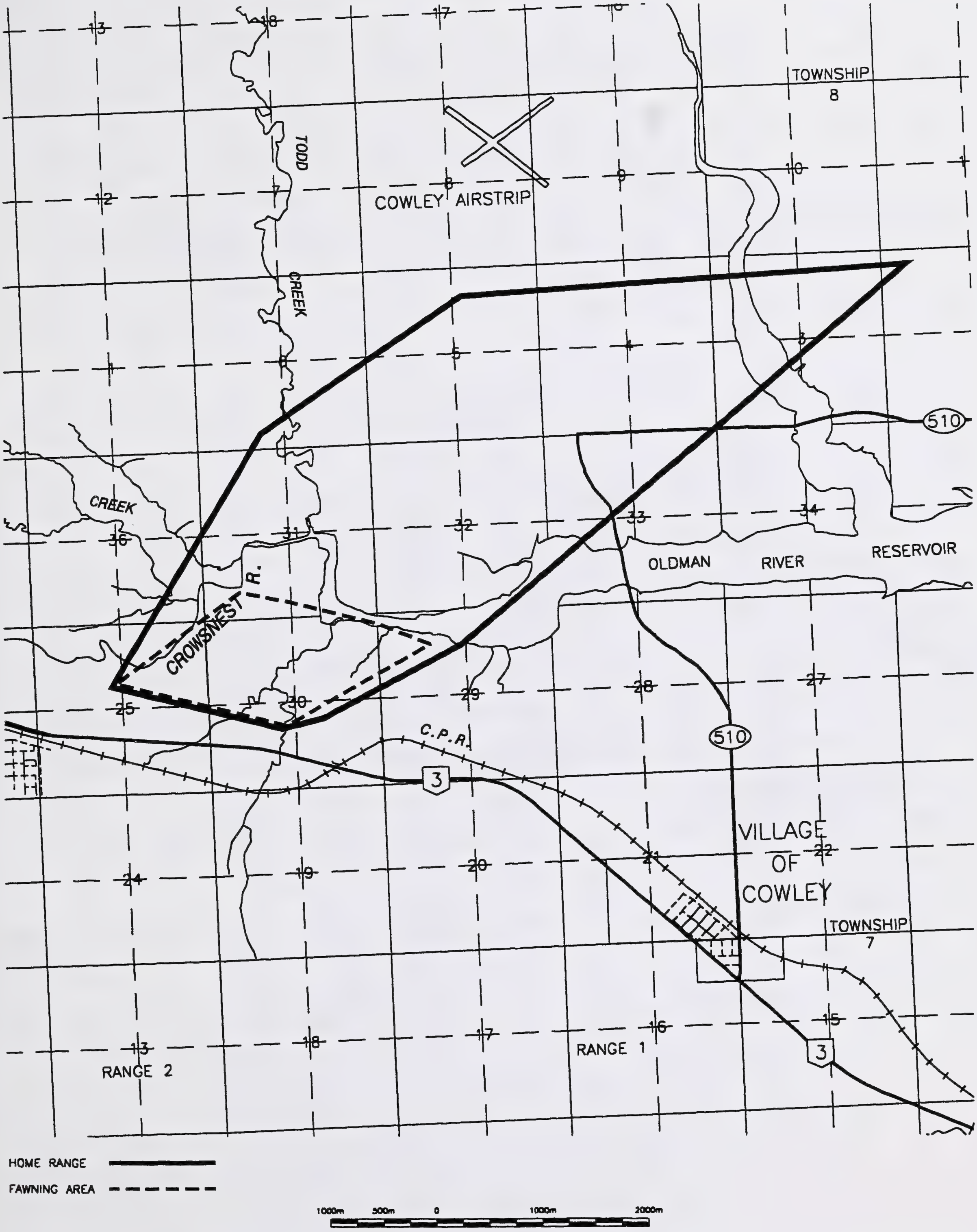
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 29

Tp 8 R 1 W5

Figure No 7 7 10



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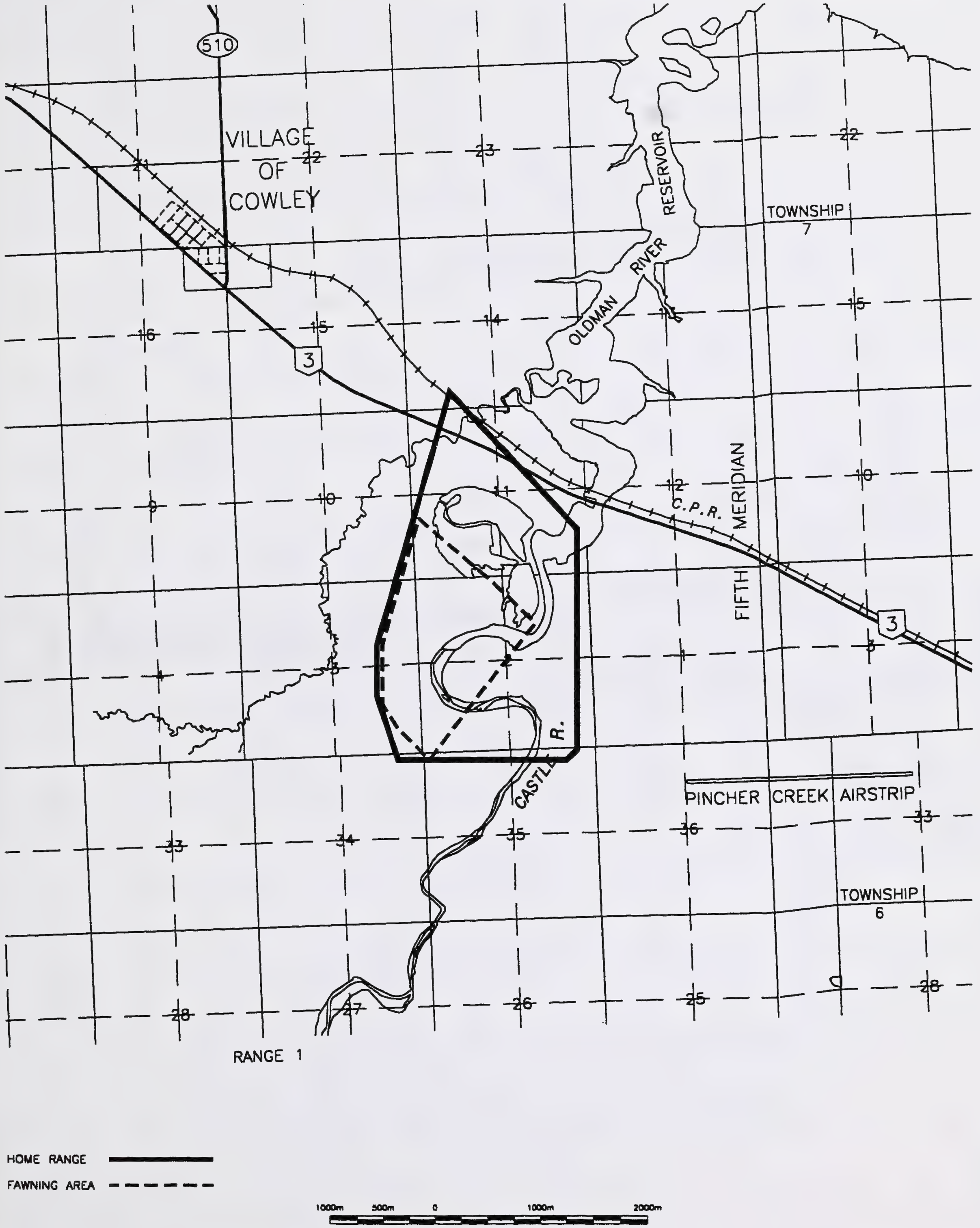
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 35

Tp 7 and 8 R 1 and 2 W5

Figure No 7 7 11



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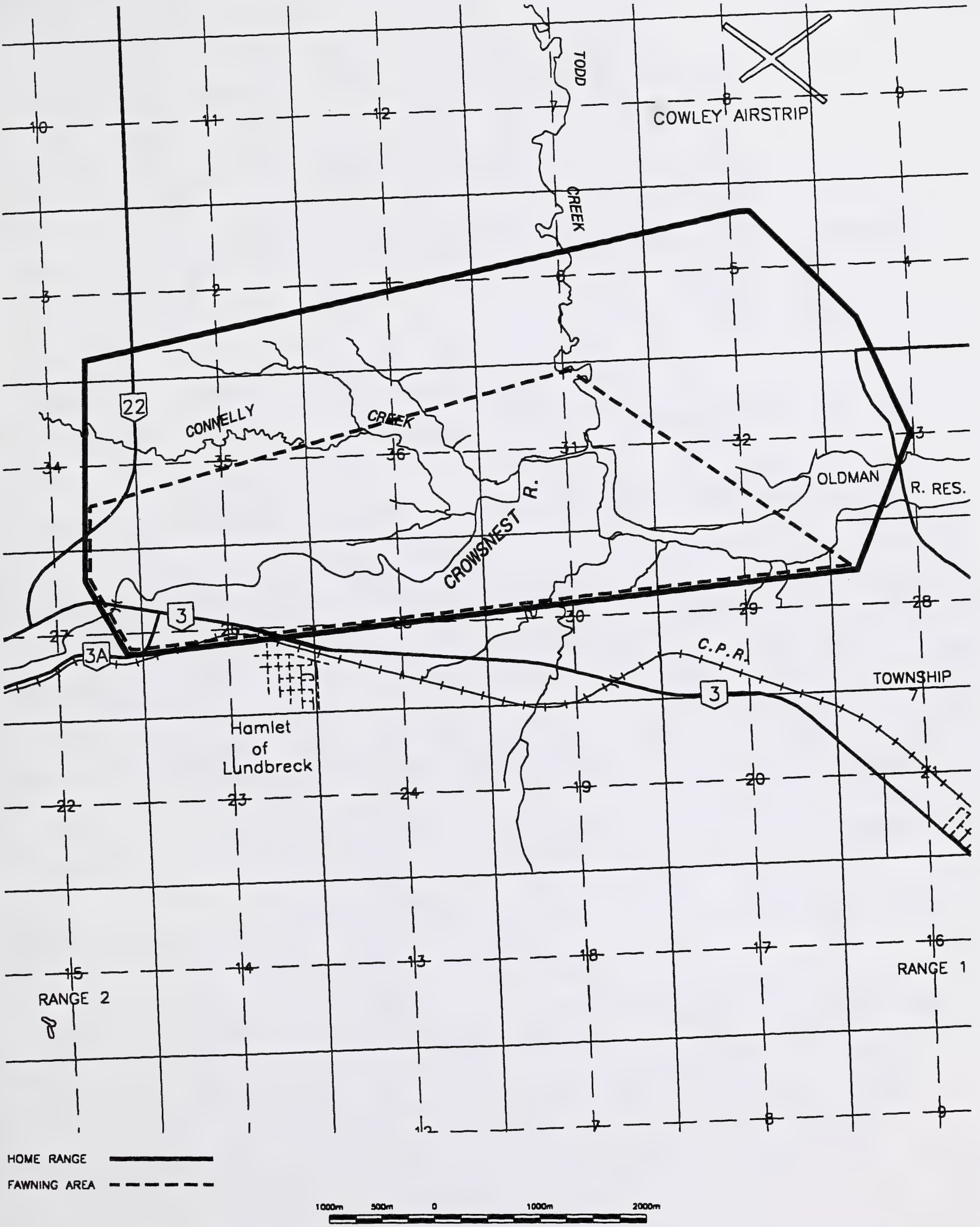
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 38

Tp 6 R 1 W5

Figure No 7 7 12



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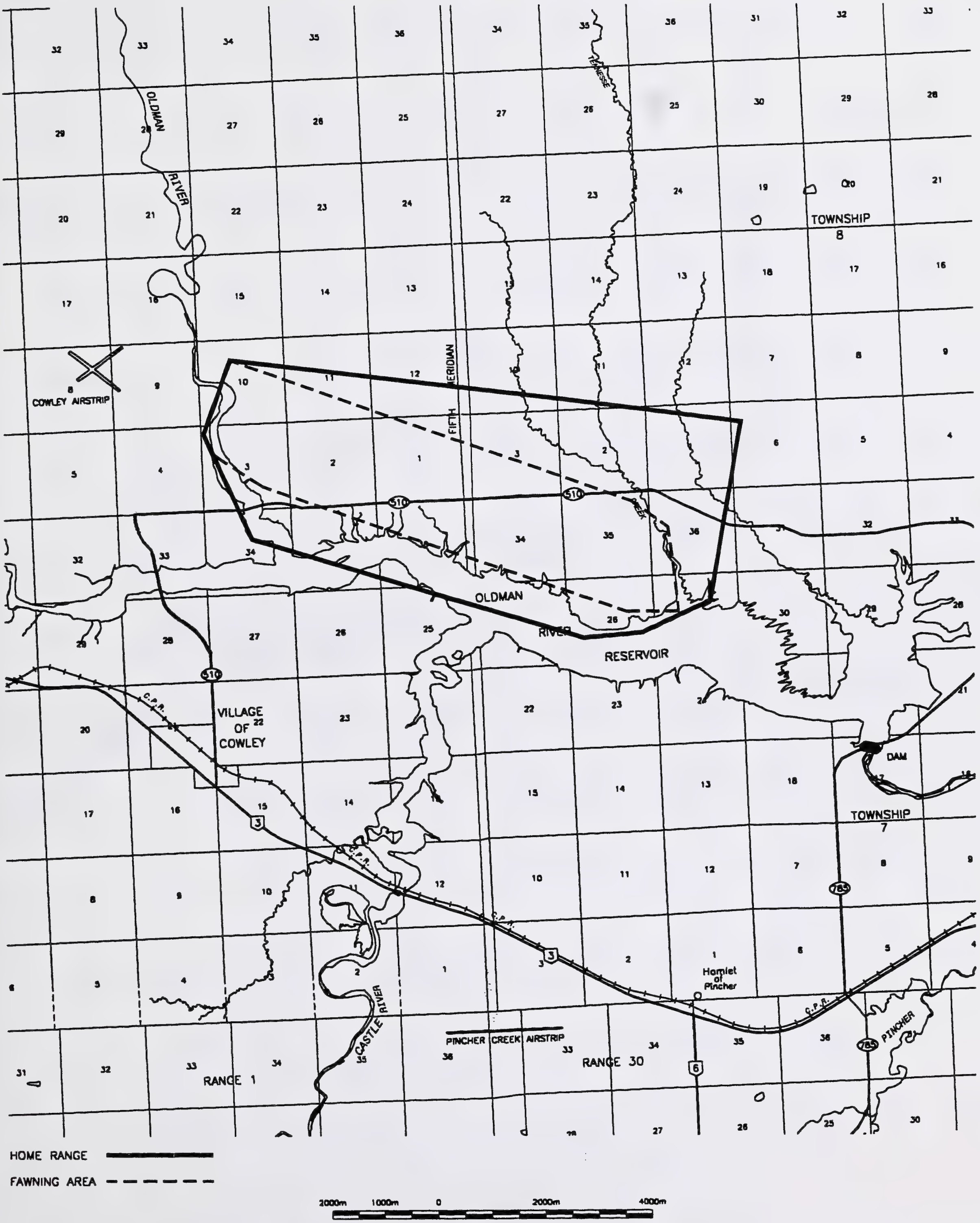
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 39

Tp 7 and 8 R 1 and 2 W5

Figure No 7 7 13



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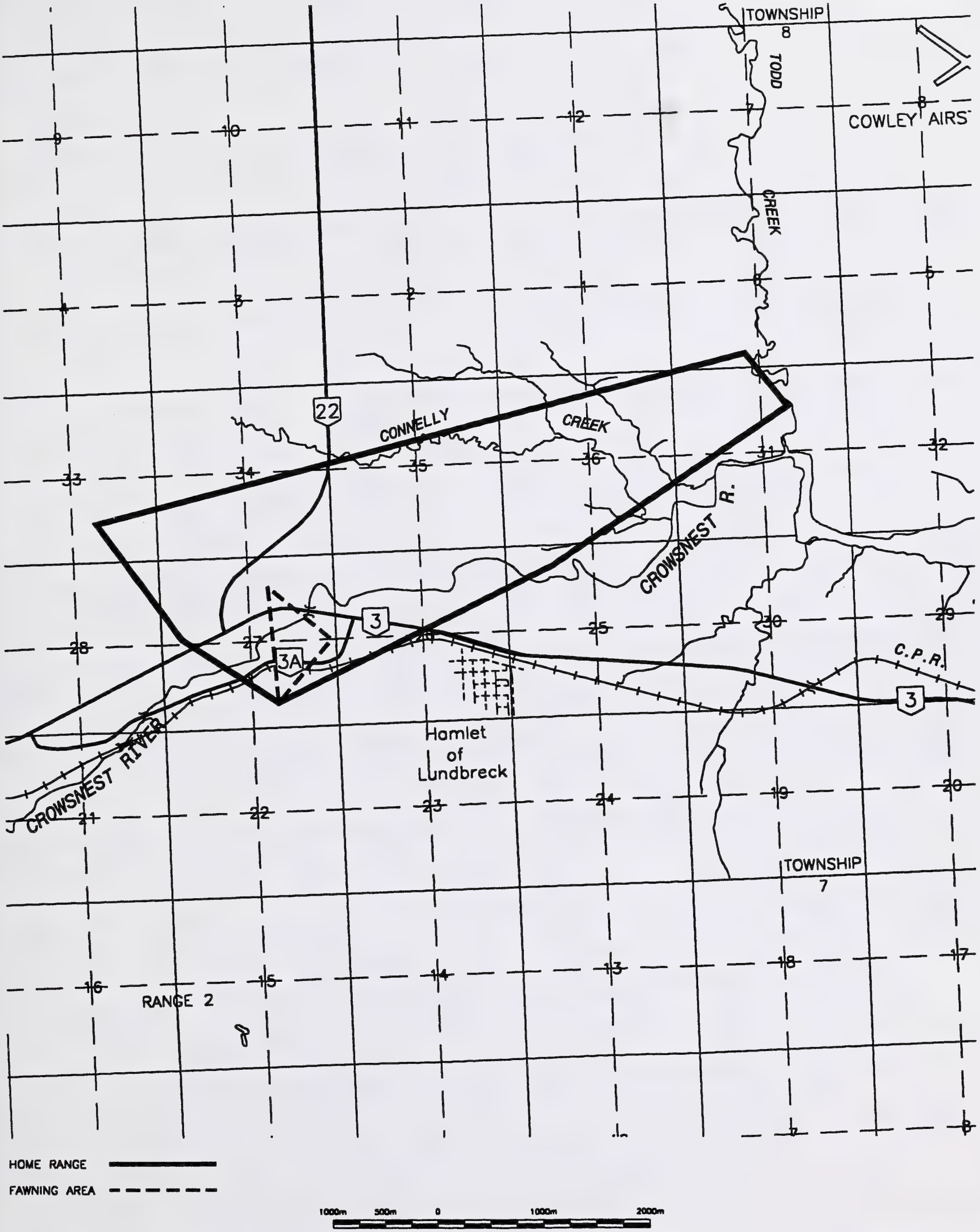
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 42

Tp 7 and 8 R 29 and 30 W4 and Tp 7 and 8 R 1 W5

Figure No 7 7 14



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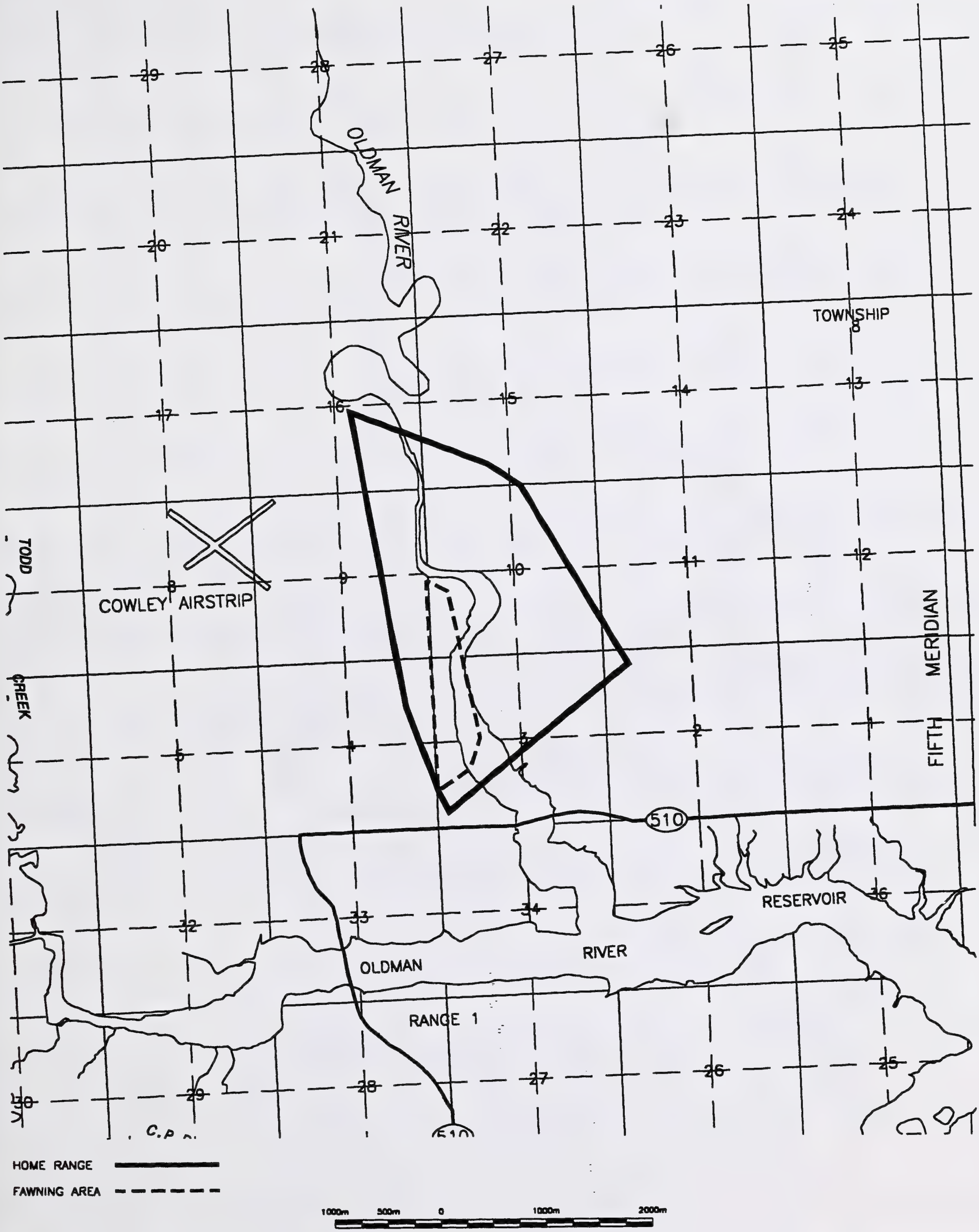
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 45

Tp 7 and 8 R 1 and 2 W4

Figure No 7 7 15



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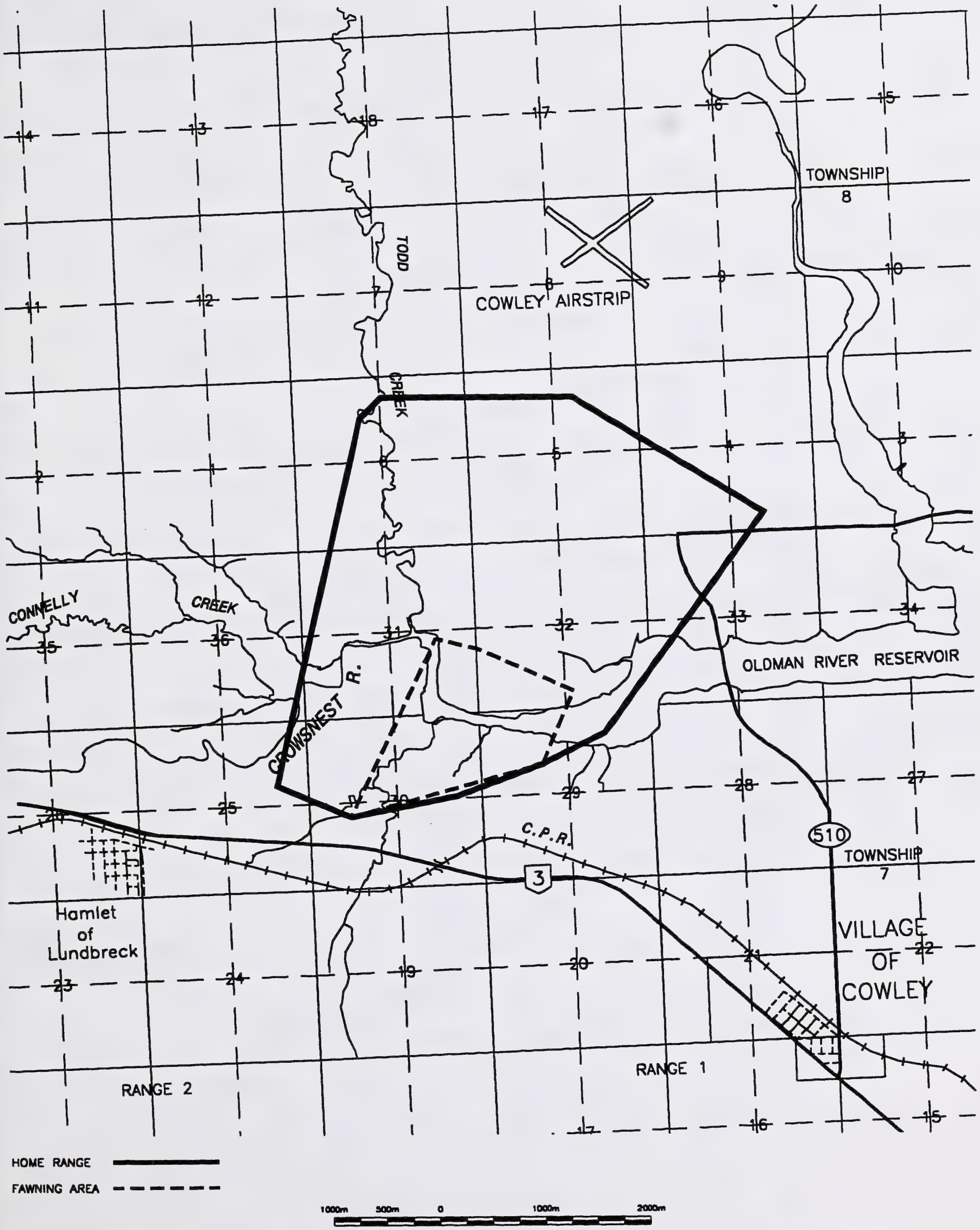
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 46

Tp 8 R 1 W5

Figure No 7 7 16



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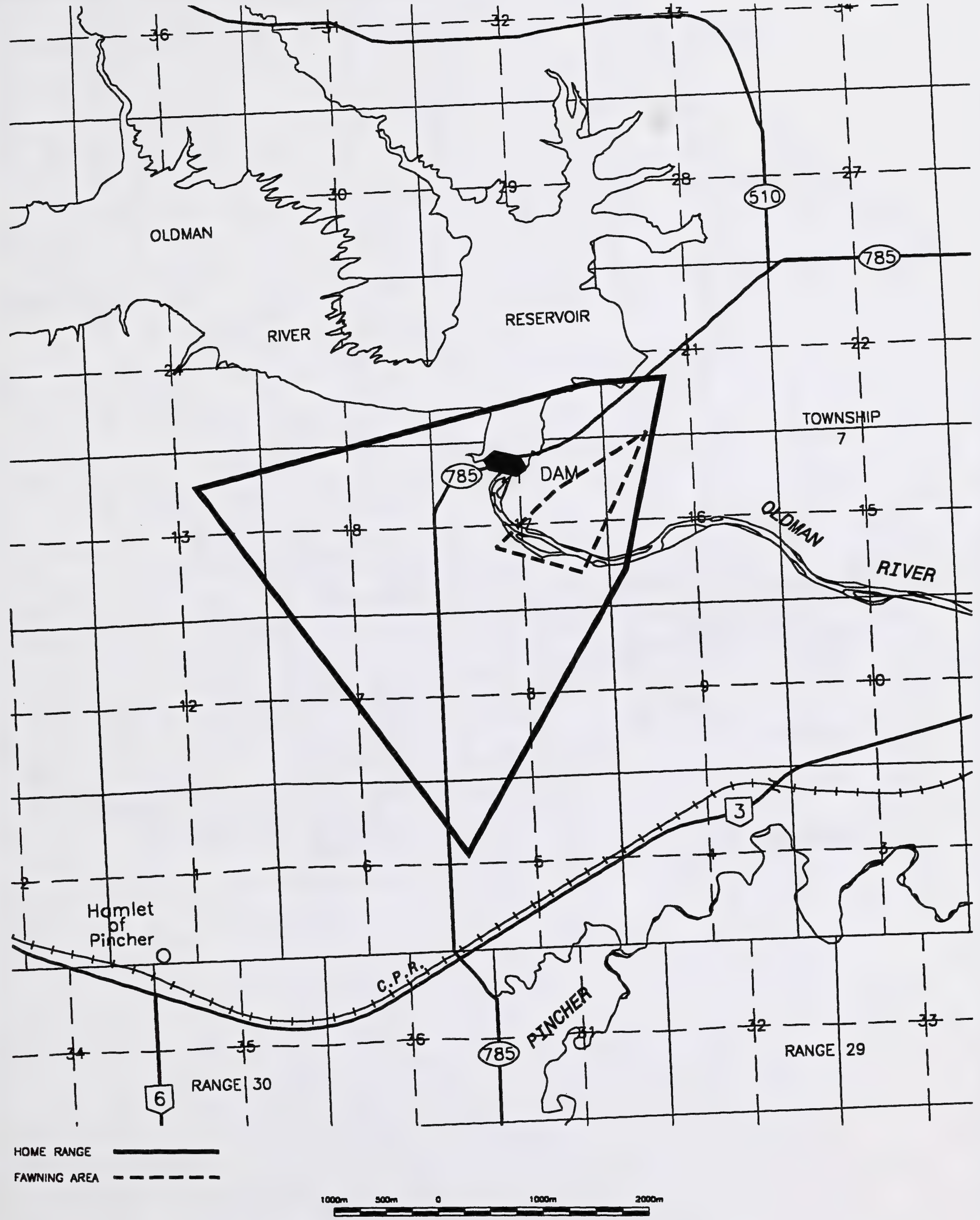
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 47

Tp 7 and 8 R 1 and 2 W5

Figure No 7 7 17



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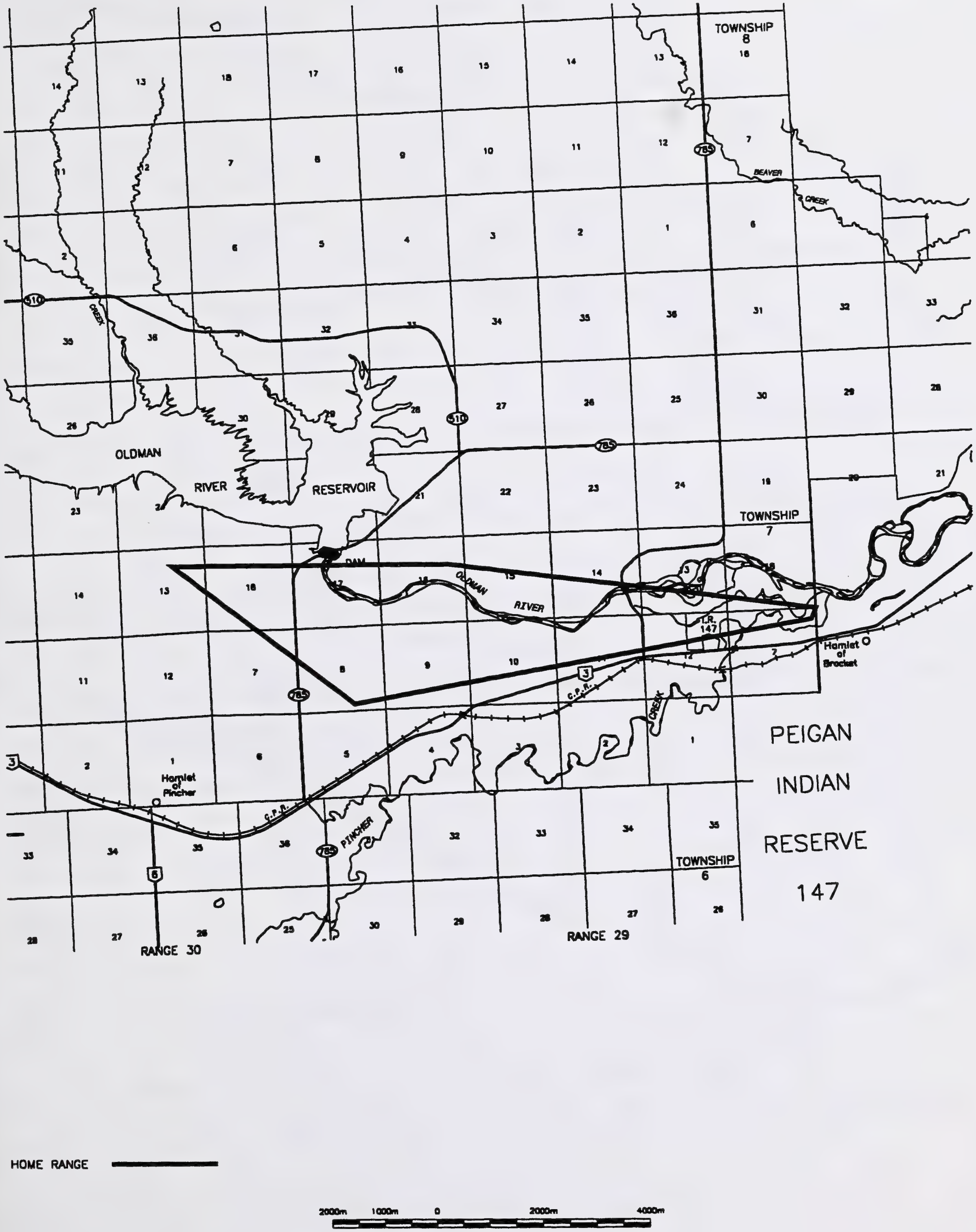
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 51

Tp 7 R 29 and 30 W4

Figure No 7 7 18



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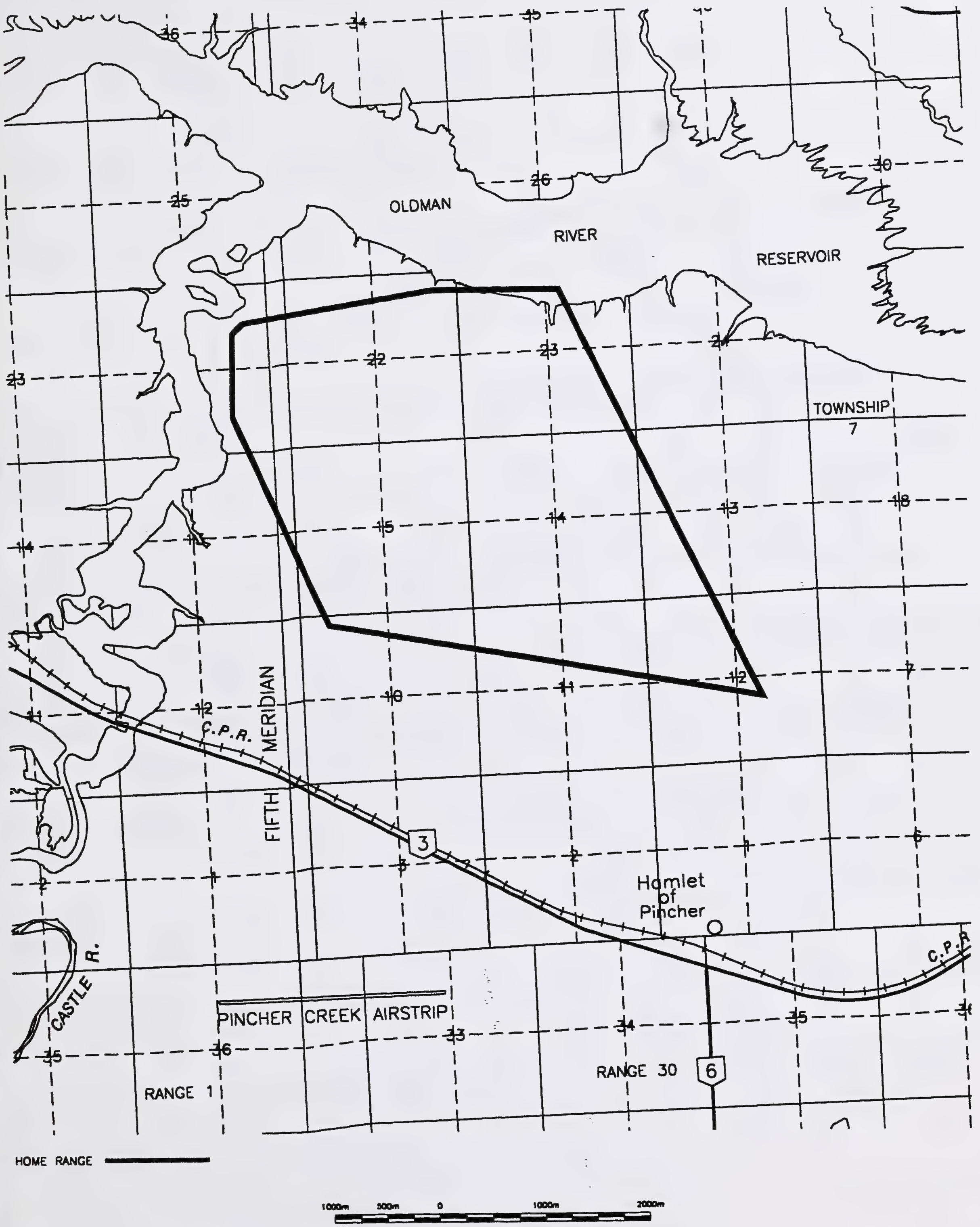
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 54

Tp 7 R 28 29 and 30 W4

Figure No 7 7 19



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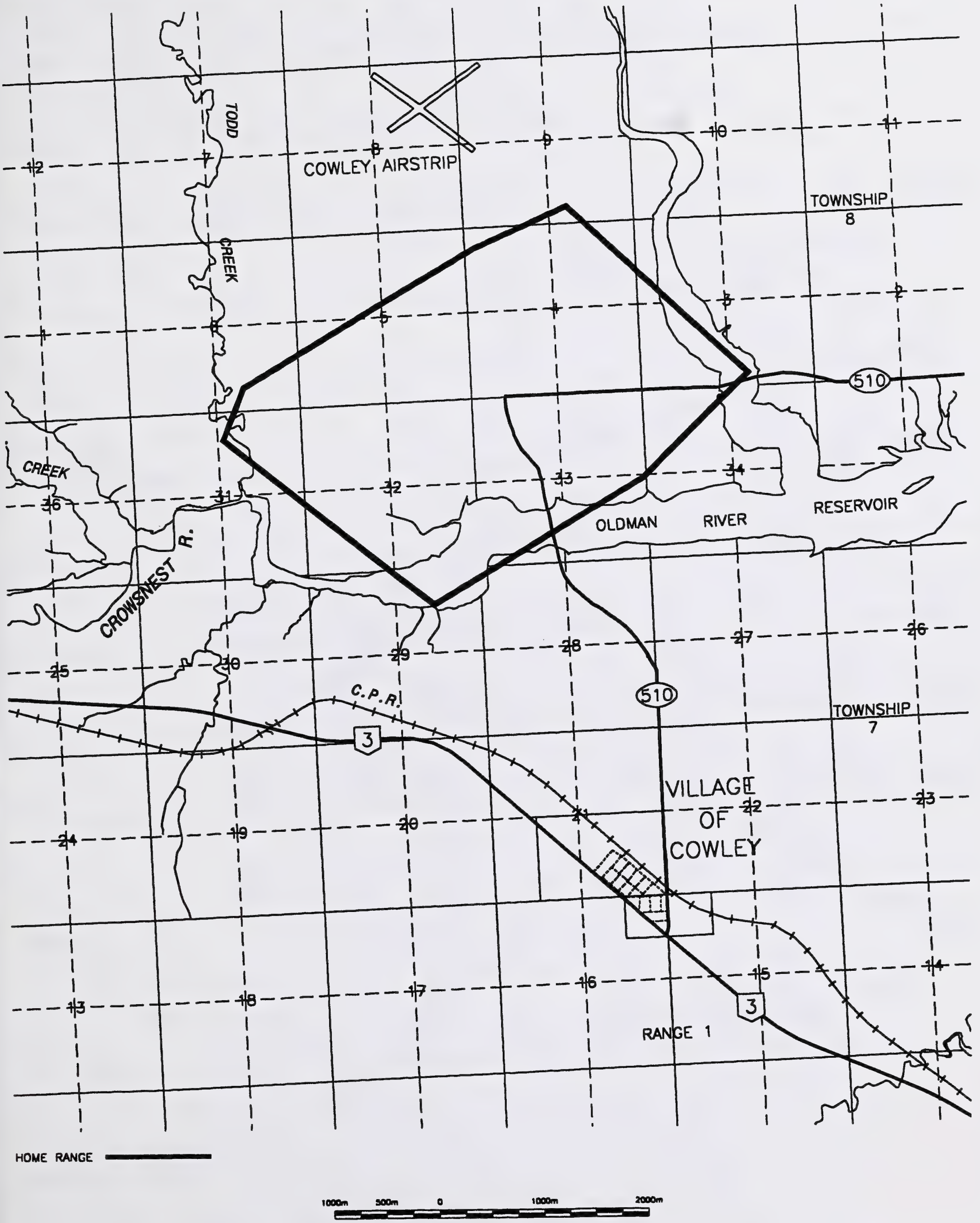
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA DEER No. 55

Tp 7 R 30 W4 and Tp 7 R 1 W5

Figure No 7 7 20



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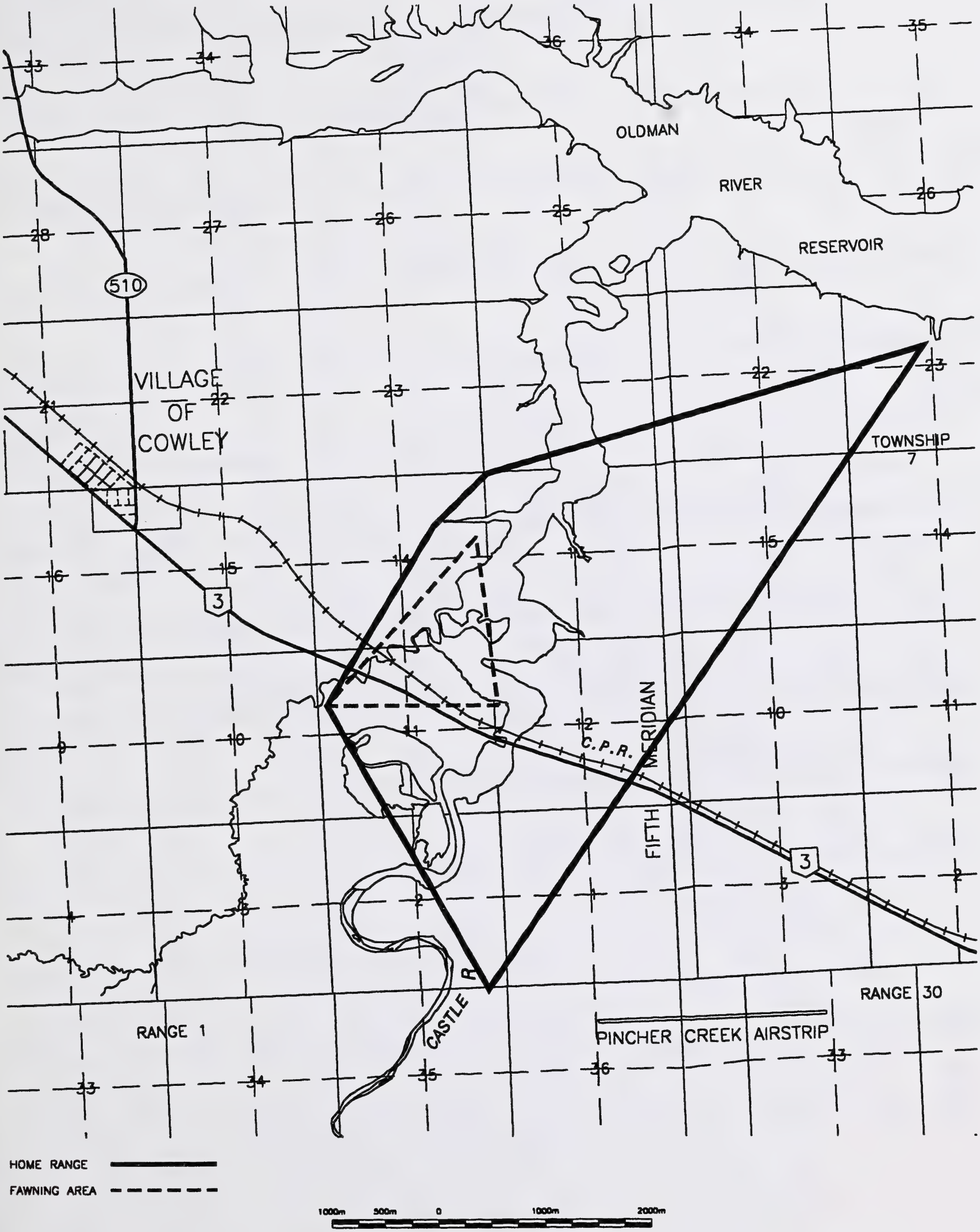
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 57

Tp 7 and 8 R 1 W5

Figure No 7 7 21



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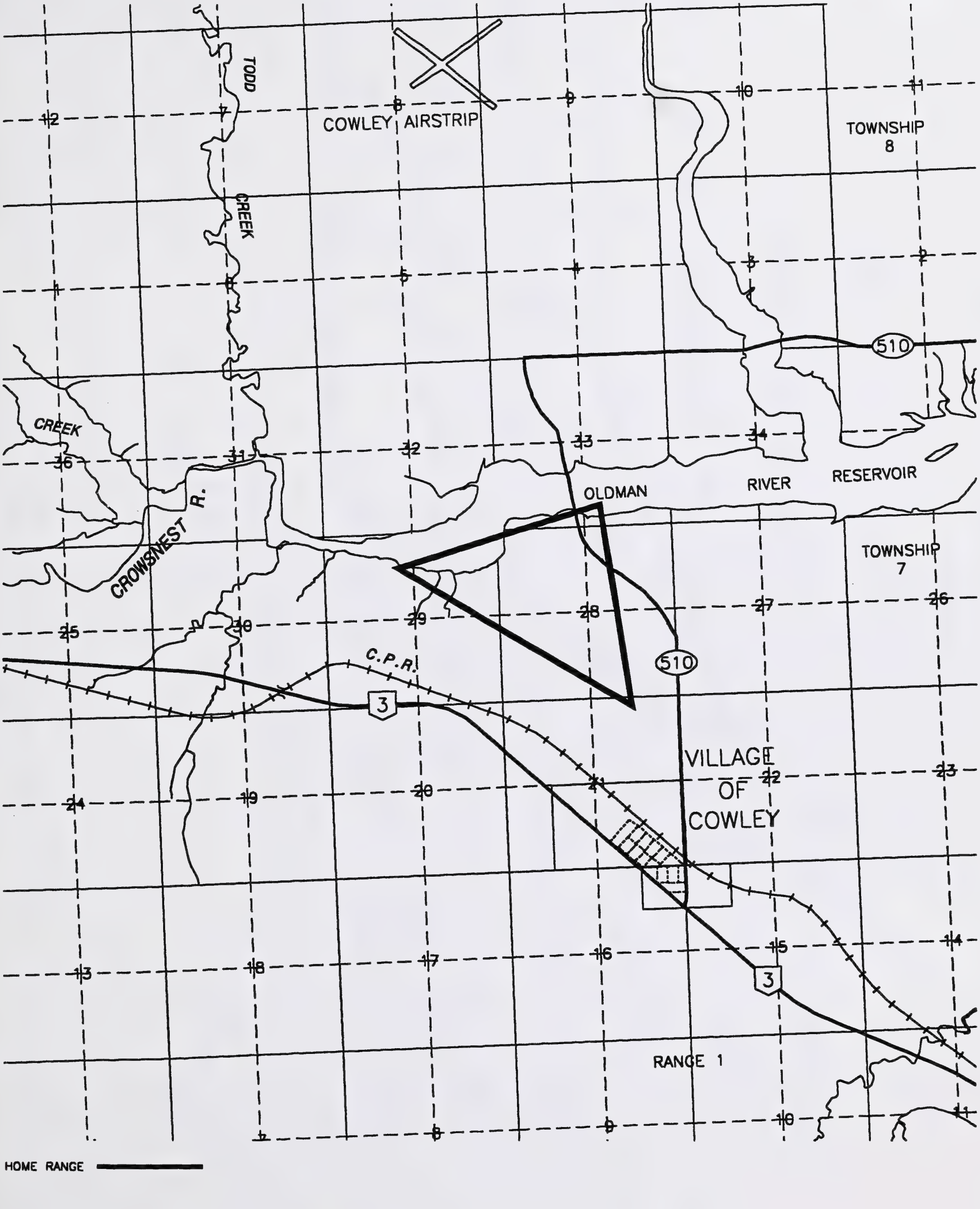
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 59

Tp 7 R 30 W4 and Tp 6 and 7 R 1 W5

Figure No 7 7 22



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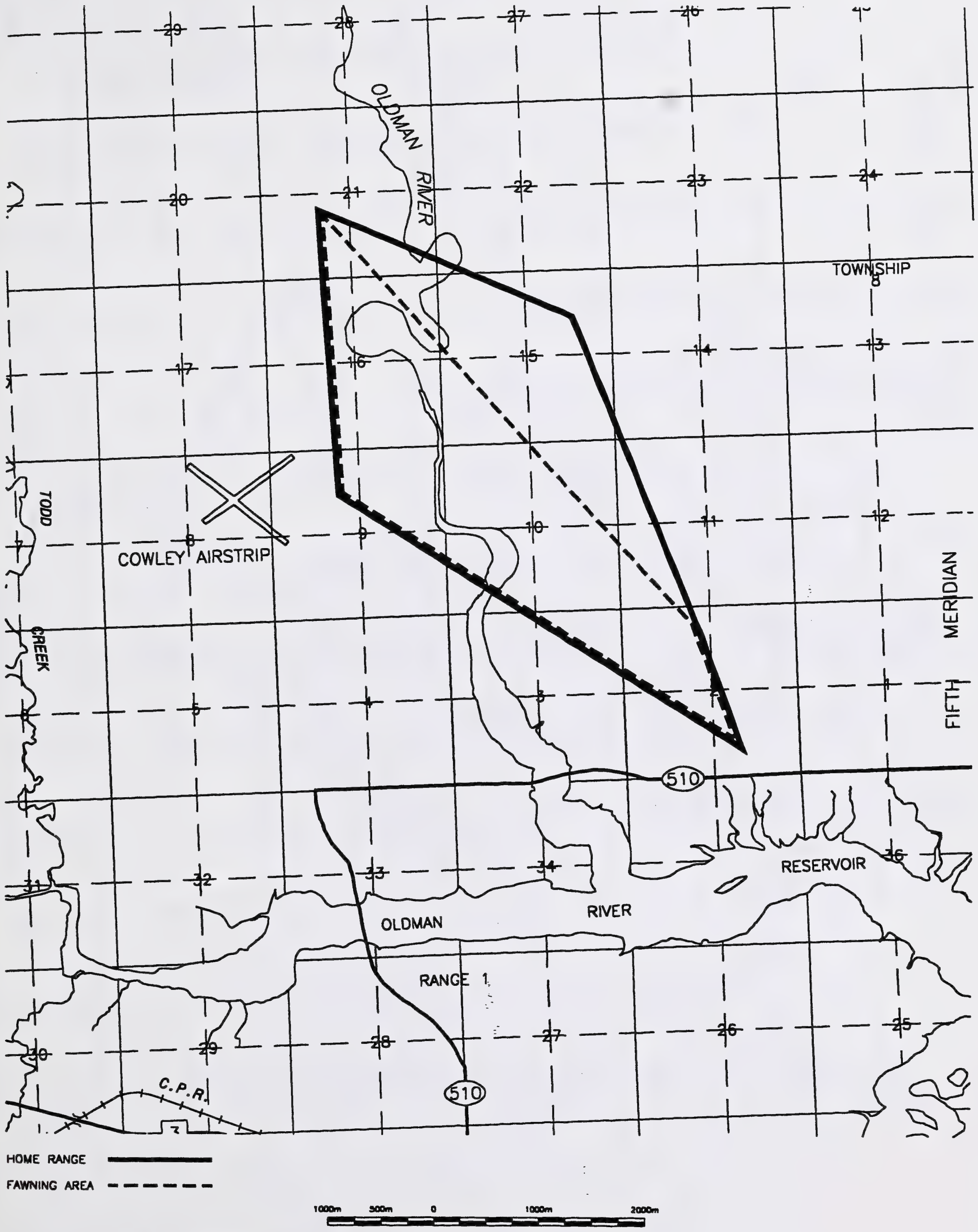
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 60

Tp 7 R 1 W5

Figure No 7 7 23



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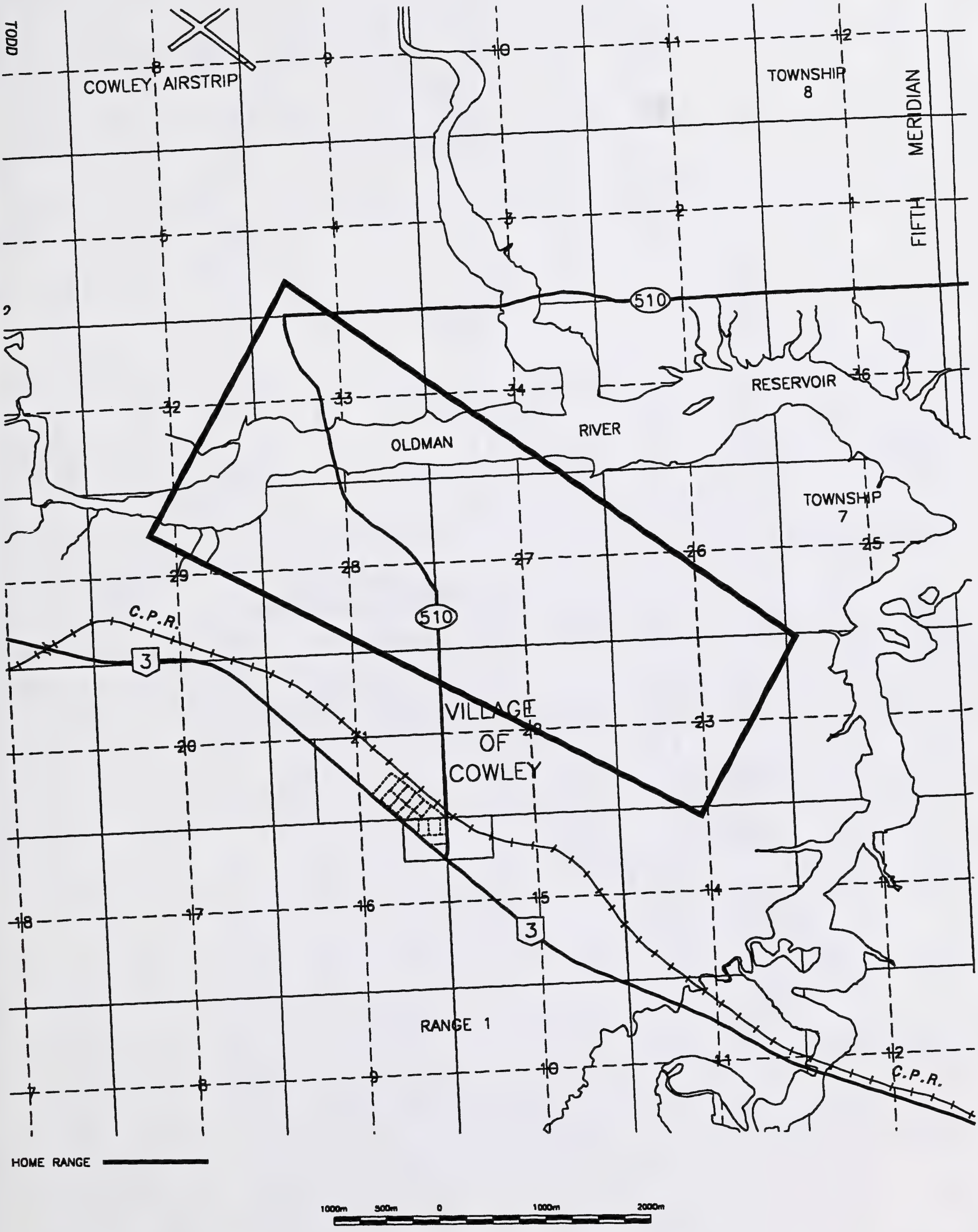
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 62

Tp 8 R 1 W5

Figure No 7 7 24



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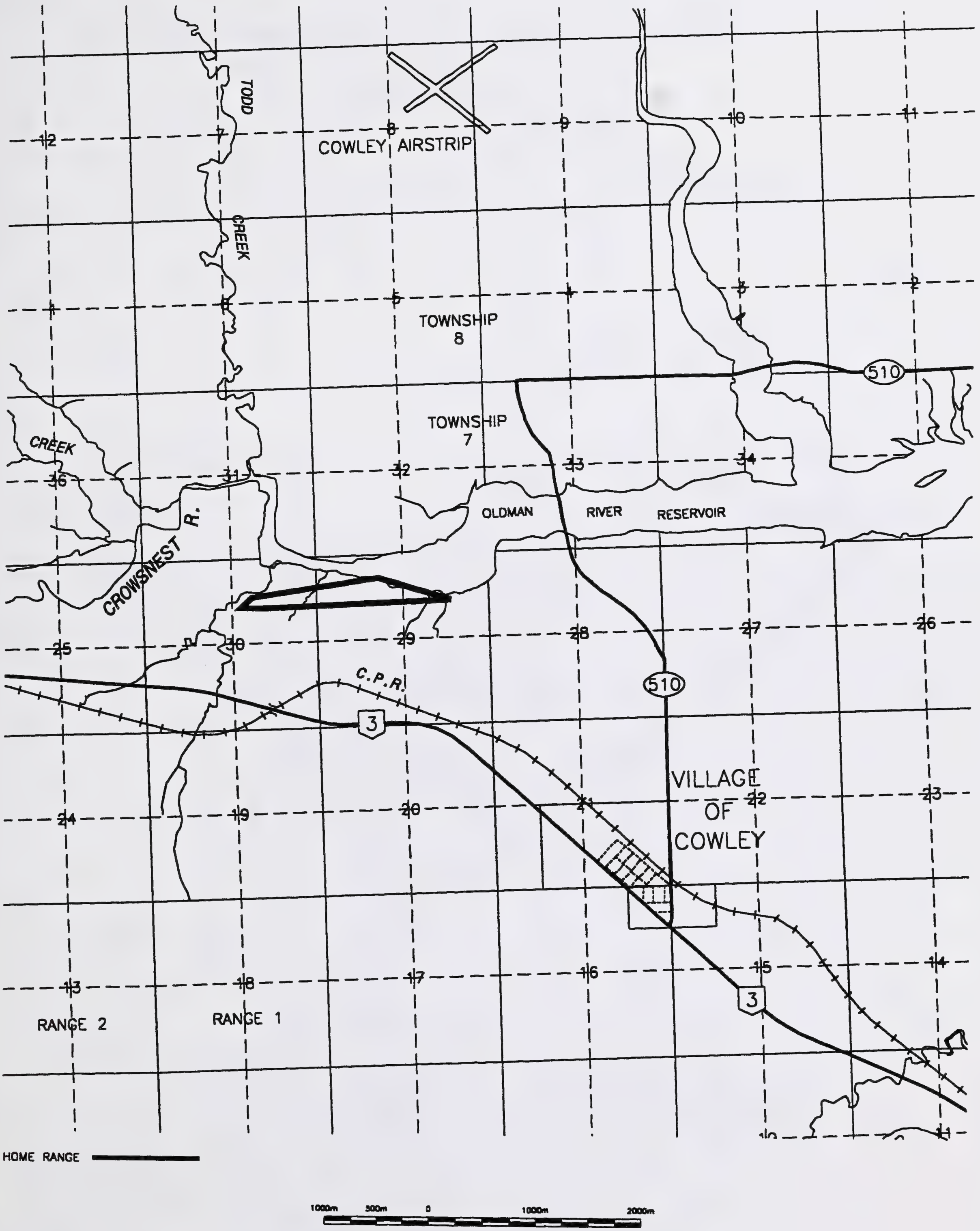
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 65

Tp 7 and 8 R 1 W5

Figure No 7 7 25



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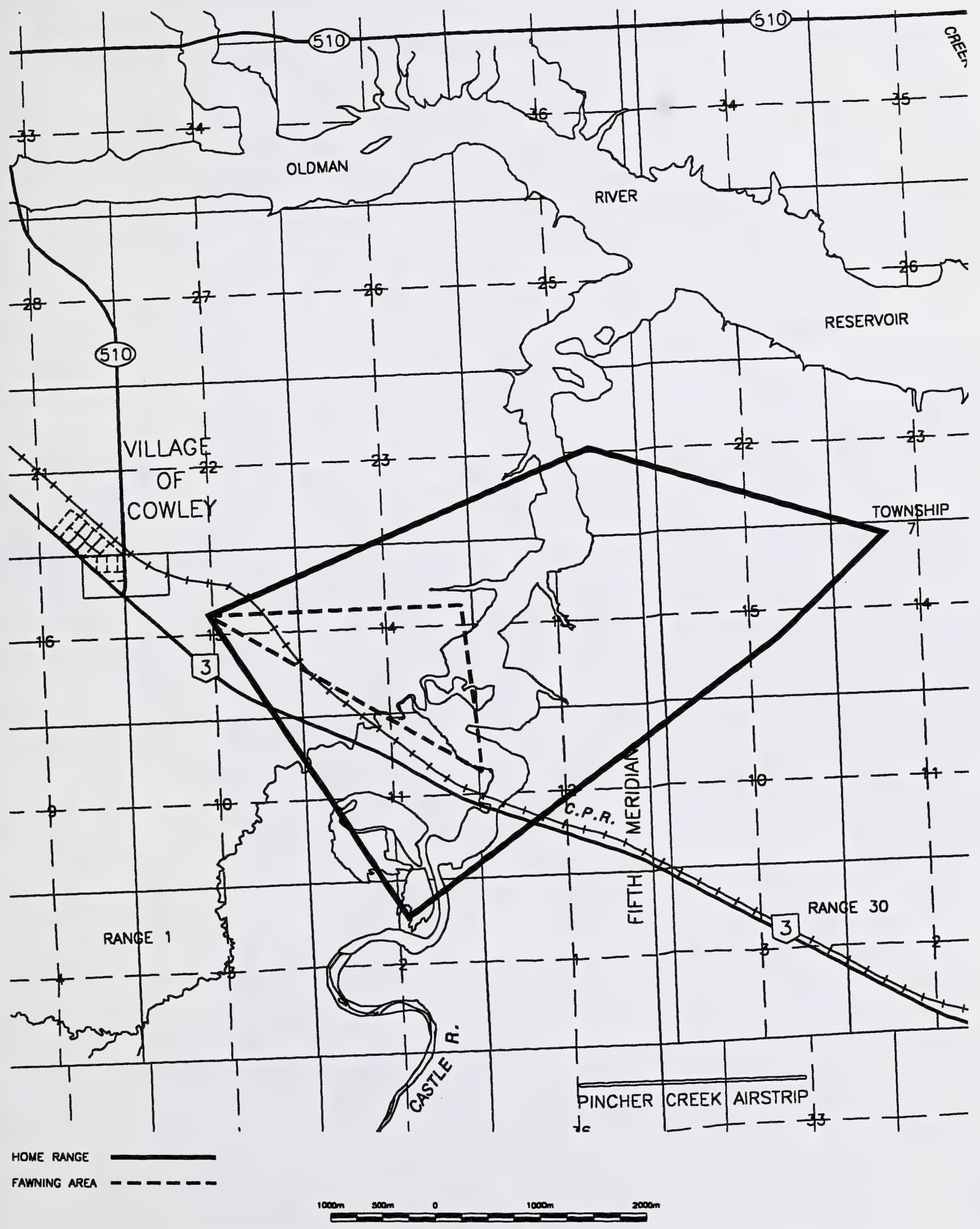
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. 70

Tp 7 R 1 and 2 W5

Figure No 7 7 26



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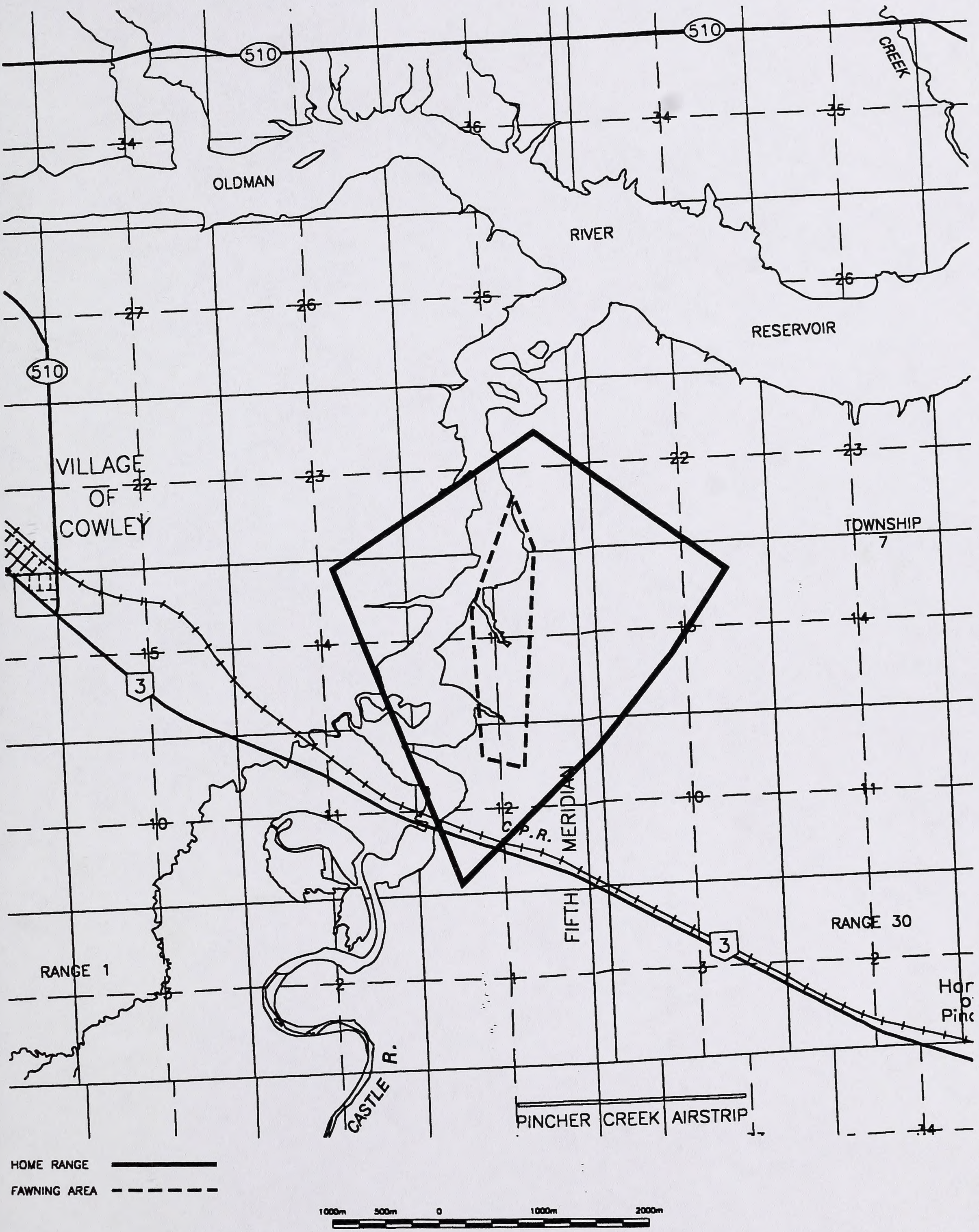
OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. Y4

Tp 7 R30 W4 and Tp 7 R 1 W5

Figure No 7 7 27



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OLDMAN RIVER DAM – MULE DEER MONITORING

HOME RANGE AND FAWNING AREA
DEER No. Y8

Tp 7 R 30 W4 and Tp 7 R 1 W5

Figure No 7 7 28

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